

The Blast Furnace *and* Steel Plant

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Christmas at Minnequa Hospital, Colorado Fuel & Iron Company.

Why cut trees for Christmas?

Why destroy and waste timber?

Why not plant and grow forests?

Why not make Christmas a birthday instead of a deathday?

The trees shown in this picture were planted on December 25, 1920.

On the 25th of December for the past five years, trees have been planted on Minnequa Hospital grounds in the presence of patients, employees, nurses and doctors.

More than a hundred of the 1700 trees on the grounds are Christmas trees and every day in the year they remind someone of Christmas.

If every family in the United States would plant a tree on the 25th of December each year, a young forest of 20,000,000 trees would be born; to this add 20,000,000 or more uncut trees and reflect upon the continued annual economic benefit to the country.

R. W. Corwin, Chief Surgeon

Electro-Metallurgical Applications

Starting Points in the Economic Industrial Utilization of Power

By J. L. McK. YARDLEY*

PART I.

This article deals with a field of engineering in which mechanical, electrical, chemical and metallurgical engineers are all interested and have responsibilities. It is a discussion of electrical power utilization developments which are based upon fundamental principles of physical chemistry and electro-chemistry. It indicates the close co-relationship of the various engineers in the solution of such industrial problems. It deals only with metals which are ordinarily employed in construction or manufacture and in the production of which large quantities of electrical power are employed. Smelting and electrolytic methods are compared. Data and illustrations on plants and equipment for the production of iron, zinc, copper, nickel, aluminum, etc., are included.

INASMUCH as the mechanical and electrical engineer should and must meet with the chemist and metallurgist on a common ground in those industries based upon physical chemistry and electro-chemistry, it is proposed to state and briefly discuss some of the more elemental things, in which mechanical and electrical engineers as well as chemists and metallurgists are vitally interested, because they constitute starting points in the economic industrial utilization of power.

1. Every chemical combination or dissociation absorbs or gives out a certain definite amount of heat and takes place at either a definite temperature or within a certain temperature range.

2. Some chemical combinations in aqueous or molten solutions are capable of being dissociated or produced by the action of electric current flowing through them.

Upon the first statement is based the practice of smelting; and upon the first and second, the practice of electrolysis. In smelting, energy, whether in electrical form or otherwise, applied in producing the chemical combination or dissociation, must supply that quantity of heat and at that temperature. In electrolysis, the energy required or absorbed is not only determined as in smelting, by the heat of chemical formation, but it is also determined by a fact established by Faraday, that the number of grams of any metal which would take the place of one gram of hydrogen in a chemical combination will be deposited by a definite quantity of electricity called one Faraday (F), in amount equal to 96,540 Coulombs.

The electrical energy absorbed or produced in electrolysis, in volt Coulombs or watt seconds, for the

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number of grams of the metal in the chemical combination, which is equal to its atomic weight, is $e \times n \times 96,540$, where e is the electromotive force absorbed or produced in the electrochemical process and n is the valence or number of bonds uniting the metal with the other elements in the chemical compound. Thus; if electric current be passed through a pure solution of copper sulphate, CuSO_4 , in water from an insoluble anode to a copper cathode, copper, Cu, is deposited at the cathode and oxygen, O, is liberated and sulphuric acid, H_2SO_4 , is formed at the anode. $e = 1.22$ volts; $n = 2$; atomic weight of Cu = 63.57. Then, 63.57 grams of Cu are deposited by $1.22 \times 2 \times 96,540 = 235,500$ volt Coulombs, or watt seconds; or, converting to pounds per Kwh., 1 Kwh. theoretically deposits

$$\frac{3600 \times 1000 \times 2.2 \times 63.57}{235,500 \times 1000} = 2.135 \text{ lbs. of Cu.}$$

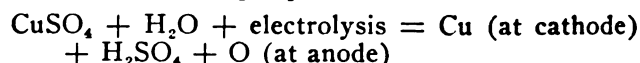
The Gibbs-Helmholtz equation definitely connects electrical energy absorbed or produced in electrolysis with heat of chemical formation and temperature of operation. According to it

$$e n F (\text{at temp. } T) = 4.187 Q (\text{at temp. } T) + n F T \frac{de}{dT};$$

where T equals absolute temperature, Q equals heat of formation in gram calories and, since one gram calorie = 4.187 Joules, $4.187 \times$ number of gram calories = number of Joules, or watt seconds, corresponding. From this equation e the theoretical voltage absorbed or produced in electrolysis, may be obtained; thus:

$$e = \frac{4.187Q}{nF} + T \frac{de}{dT}.$$

The second term at the right is the temperature coefficient of the electromotive force multiplied by the absolute temperature. It may be considered as a term of correction or refinement and since it is small at ordinary temperatures, the approximate result obtained by using only the first term is sufficiently accurate. For example, with the aid of this equation, the decomposition voltage for copper sulphate, used above, may be obtained. As shown by the following equations, when an electric current is passed through a solution of copper sulphate, both CuSO_4 and H_2O are dissociated and H_2SO_4 is formed.



Molecular weight:

$$(63.6 + 32 + 4 \times 16) + (2 \times 1 + 16) = 63.6 + (2 \times 1 + 32 + 4 \times 16) + 16$$

Gram, kilogram or pound equivalent:

$$159.6 + 18 = 63.6 + 98 + 16$$

Heat of formation or dissociation — gram calories:

$$197,500 + 69,000 = \text{heat of electrolysis} + 210,200.$$

$$\text{Then heat of electrolysis} = 197,500 + 69,000 - 210,200 =$$

$$200 = 56,300 \text{ gram calories; and } e = \frac{56,300 \times 4.187}{96,540 \times 2} = 1.22 \text{ volts.}$$

So much for fundamental theory; but very frequently, the heat of formation of the material smelted or electrolyzed which, in any smelting or electrolytic operation, is the primary thing determining the amount of energy required is so masked by other factors that in calculating the final or overall efficiency or economy of a process, the initial starting point is either not determined accurately at all or is practically lost sight of. In the smelting process, heat is absorbed or is obtained from:

1. The various heats of combinations or dissociation that are operative in the rearrangements of chemical combinations which take place at or before reaching the smelting temperature.
2. Raising the valuable chemical combination and such other chemical combinations as are necessary to the requisite reactions, and the furnace to the smelting temperature.
3. Radiation, convection, conduction heat losses.
4. Electrical supply equipment.

In the electrolytic process, heat is absorbed or is obtained from:

1. The heat of formation or dissociation active in the main reaction.
2. The heats of formation or dissociation in the various secondary reactions that go on in commercial electrolytes at or near the anode or cathode.
3. Raising the electrolyte and electrodes to operating temperature.
4. Radiation, convection, conduction, heat losses.
5. Electrical loss in the form of or equivalent to leakage, thus reducing the ampere efficiency, that is, the number of grams of metal deposited per Faraday from the theoretical 100 per cent, which is as previously stated.
6. Electrical supply C²R losses, which show up in voltage drop in the various component parts of the electrical circuit such as the electrolyte, the anode, cathods, contacts, bus leads or conductors and the electrical supply equipment itself and result in a total impressed voltage, E , being required, which is much larger than e . If no other external heat is provided, it is obvious that ampere efficiency (No. 5 above) $\times \frac{e}{E}$ is a measure of the inherent efficiency of the electrochemical process at a particular plant.

The electrical losses mentioned just above are all perhaps of a nature with which mechanical and electrical engineers are generally acquainted, except those taking place in the electrolyte itself and these, accordingly, require special study to determine variations due to variations in temperature, acidity, current density and other factors. For example, the copper sulphate solution of composition ordinarily employed in copper refineries has a negative temperature coefficient of approximately .5 per cent per deg. F. within the range of temperature ordinarily employed, so that appreciable saving of power results from operating at the highest practicable electrolyte temperature, that is, around 150 deg. F. Other ohmic losses being small compared to the electrolyte loss a power saving of 15 per cent results as compared to operation at 120

deg. F. This partly accounts for the economy of copper refineries which generate their own power from steam and operate in the neighborhood of 20 per cent non-condensing, so as to provide steam for electrolyte heating, and experience as a result a net saving somewhat more than 10 per cent. Mention should, perhaps, be made also at this point of the fact that in the electrolytic refinery the opposite reaction is going on at the anode to that taking place at the cathode, so that the resultant e is zero and E is the result of resistance drop purely. As a further example, the acidity of the zinc sulphate (ZnSO_4) solution at one of the largest electrolytic zinc reduction plants ranges between 5 per cent and 9 per cent. With constant voltage applied, a change of 1 per cent in the acidity of the solution changes the resistance so as to produce about a 15 per cent change in current density. This is of importance because it is indicative of the fact that control of the electrolytic cell room conditions can readily be at least partially obtained through variations in acidity, thus relieving the electrical supply equipment and rendering it unnecessary that that equipment be provided inherently with an impracticable amount of voltage varying capability.

From a consideration of the various items of the total heat appearing in the smelting or the electrolytic process, it is apparent that the only really useful energy is that taking part in the final or main reaction or that energy anywhere else in the process that tends to reduce the amount required in the main reaction. The useful heat is a small part of the whole and all the various losses and secondary reactions must be taken into account in determining the over-all economy. Where possible, the secondary reactions should be made to work in favor of, rather than against, the process and where external heat can be supplied more cheaply, as it has been shown can be done by steam in the copper refinery, than from electrical energy this should be done. In smelting, the largest quantities of heat appear or are absorbed under headings 1, 2 and 3, above. In electrolysis, the quantities of heat involved under 1, 2 and 3 also constitute by far the major part. The radiation, etc., losses under 4, for electrolysis are so much less than under 3, for smelting, owing to the lower temperature of operation that this partly accounts for the comparative economy usually to be obtained.

To state the case briefly, the energy required for electric smelting is a function of the amount of furnace charge, whereas, the energy required for electrolysis is a function of the amount of metal deposited. This is the fundamental difference between the two processes and the one which determines the economic success of either in any application. It is not an appreciable disadvantage so far as efficiency is concerned in the electrolytic process, at least in aqueous solutions, to have large quantities of the materials in process. For example, in the case of a large electrolytic copper reduction works, more than one-half month's production would be tied up in the electrolyte alone and for a daily production of 60 tons of copper there would be in the neighborhood of 30,000 tons of electrolyte. This large body of electrolyte, flowing in cycle, contains only about 3 per cent of copper when it enters the electrolytic cell room and still contains about 2½ per cent of copper when it leaves it to return to the ore beds. For economic smelting, on the other hand, of the more common metals, it is essential that only small

quantities of material in proportion to recoverable metal be in process. Low priced electric energy in conjunction with high priced fuel is a favorable condition for economic electric smelting, but high grade, concentrated materials in process are also essential.

In Norway and Sweden, particularly, there are large economic electric smelters producing pig iron from iron ore. A type of furnace, such as shown in Fig. 1, is employed, which is similar to the blast furnace. The gases are recirculated but there is no blast and external heat to produce the temperature neces-

sary for the reaction is introduced through six electrodes from 3000 kw. transformers. The energy consumption is in the neighborhood of 2400 kwh. per long ton, or 1.09 kwh. per lb. of pig iron.

It is of particular interest that the product equals 47.5 per cent of the furnace charge. The charge per ton of product is approximately, 3,680 lbs. of iron ore containing 61.5 per cent of iron, 132 lbs. of lime stone, 815 lbs. of charcoal and 17.5 lbs. of electrode consumed, or a total of 4,645 lbs. The ore consists of 20.64 per cent Fe_2O_3 and 64.96 per cent Fe_3O_4 , or 760 lbs. and

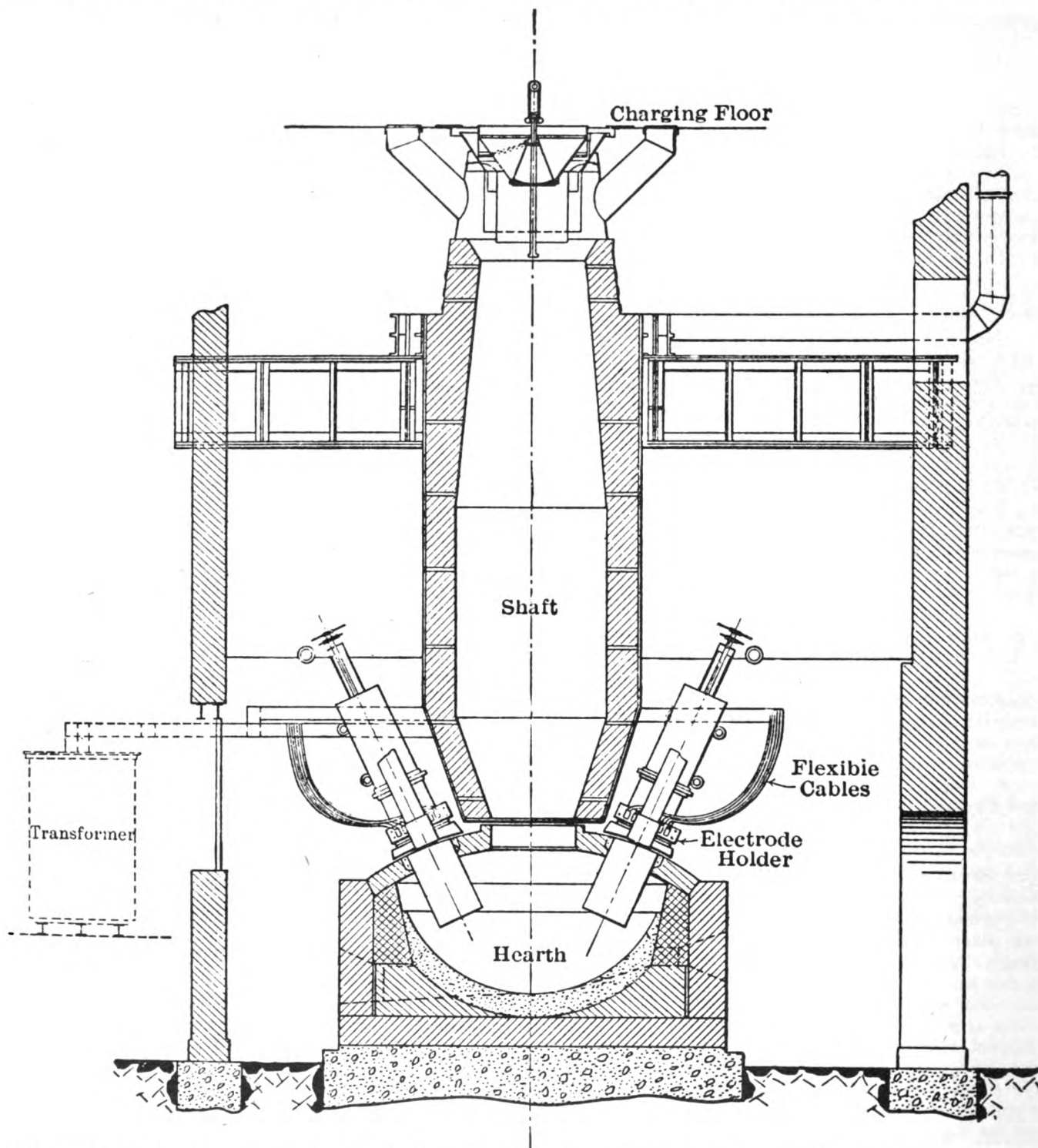


FIG. 1.—Shaft type, electric smelting furnace for pig iron. This type of furnace allows for circulation of gas so that about 25 per cent of the heat value of the gas formed is utilized within the furnace. Of the total Kwh. supplied about 6½ per cent to 7 per cent is lost in the cooling water and 20 per cent to 25 per cent by radiation.

2385 lbs., respectively, per ton of pig iron produced. It is, of course, understood, that electric smelting, as fuel smelting, require fluxes and reagents to produce chemical reactions at the smelting temperature. Hence, the amounts of limestone and charcoal stated above. In view of the high percentage of the final product in the initial furnace charge, owing to the high grade iron ore employed, an analysis of the way heat is absorbed or produced, in the main reactions at least, will be of interest as indicative of the efficiency and economic possibilities not only of this particular electric smelting operation but of other similar operations.

1. Reduction temperature 900 deg. C.—probable equation:



Molecular weight — weight equivalent:

$$231.5 + 36 = 167.5 + 2(28) + 44$$

Heat of formation or dissociation — gram calories:

$$270,800 = 2(29,160) + 97,200 + \text{electric heat.}$$

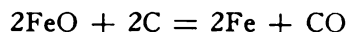
$$\text{Then, electric heat} = \frac{115,280 \times 3.968 \times 1,000}{167.5 \times 3,412} =$$

800 Kwh. per long ton.

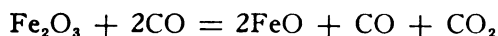
As there are $\frac{2,385 \times 167.5}{231.5} = 1,725$ lbs. of Fe produced

from Fe_3O_4 , 627 Kwh. will be required.

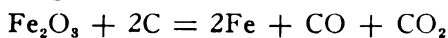
2. Reduction temperature 800 deg. C. — probable equation:



Reduction temperature 700 deg. C. — probable equation:



Combining:



$$159.7 + 24 = 111.7 + 28 + 44$$

$$197.700 = 29,160 + 97,200 + \text{electric heat.}$$

$$\text{Then, electric heat} = \frac{71,340 \times 3.968 \times 1,000}{111.7 \times 3,412} =$$

742 Kkh. per long ton.

Then, the 535 lbs. of Fe produced from Fe_2O_3 will require 181 Kwh. Then, the total 2,260 lbs. of Fe (including 3 per cent loss), produced will require 808 Kwh. theoretically.

3. The ore carrying the reduced Fe is raised to a much higher temperature 1,400 deg. or 1,500 deg. C. in the crucible of the furnace by the addition of about 342 Kwh. per ton of Fe where the Fe melts, uniting with 3 per cent or 4 per cent of carbon and a fractional percentage of silicon to form the fusible product known as pig iron. There are several minor reactions in the reduction of the silicious gangue, in this case 14.4 per cent of the ore, and in the decomposition of the limestone, which fluxes the gangue and the ash of the reducing agent, if any, to form a fusible slag floating on top of the iron which is tapped and thrown away. These reactions do not materially affect the total electric heat required which, therefore, is ap-

proximately 1,150 Kwh. per long ton of white low silicon iron suitable for making steel.

Accordingly, the inherent efficiency of the process comparable to the energy efficiency, $\frac{e}{E} \times \text{Amp. Eff.}$

for electrolytic processes, is $\frac{1150}{2400} = 48$ per cent.

Whereas, the furnace operating voltage is usually from 70 to 80 volts, equipment having a range of from 60 to 120 volts is required.

In Norway and Sweden also, there has been extensive economic electric smelting of zinc. Here also, the raw material employed has been high in the values produced. It has consisted largely of cheap, slagging lead zinc, say 35 per cent zinc and 10 per cent lead, ores, making beside metallic zinc, lead bullion and copper matte. In other words, it is really a separating process, each of the three products requiring further work to place it in marketable form. The power consumed is from 2 to 2½ Kwh. per lb. of zinc produced. Electrical units of about 1,000 kw. each have been largely employed. Equipment having a voltage range for the furnace of from 50 to 180 volts, or 90 to 180 volts, is required.

(To be continued.)

The metal-mining industry of the United States employed 123,279 men in 1923, representing an increase of 17 per cent over the number employed in 1922, according to statistics compiled by the Department of the Interior through the Bureau of Mines. The volume of work performed was equivalent to 36,559,805 men-shifts of labor, or 25 per cent more than in the preceding year. The death rate from accidents at the mines was lower than has ever before been recorded, but the non-fatal injury rate continued to rise. The fatality rate was 3.01 per thousand men employed, calculated on a standard of 300 work days per man per year; the injury rate was 275 per thousand men. Prior to 1923 the lowest fatality rate was 3.09 for the year 1921; the highest was 4.45 for 1911. The actual number of men killed by accidents in 1923 was 367; the number injured was 33,563, each injury incapacitating the employee for one day or more.

The reduction in the fatality rate for 1923 is credited to iron mines and to the gold and silver group of mines, as there was a slight increase in the fatality rates for mines producing copper, lead and zinc and non-metallic minerals.

The volume of work done, as indicated by the aggregate number of man-shifts of labor performed by all employees, indicated increased activity in all of the major branches of mining. The increase, as compared with 1922, was 37 per cent at copper mines, 35 per cent at iron mines, 11 per cent at gold and silver mines, 19 per cent at lead and zinc mines in the Mississippi Valley States, and 12 per cent at mines producing non-metallic minerals.

Not only did the industry as a whole enjoy greater activity than in the preceding year, but the average number of work days per man was 297 in 1923, as compared with 276 days in 1922. This increase likewise was shown for all branches of mining.

Preparation of Metallographic Specimens

A Compilation of Definite Facts and Rules Which Will Enable
An Investigator to Prepare Satisfactory Specimens

By JOHN D. GAT*

It is hard to tell how many young and promising metallurgists just from the hospital walls of a college will have this year their spirit broken and for a week or so will be seriously contemplating the change of the profession when their best efforts to prepare decent specimens continually and ignominiously fail, but judging from the sweet recollection on the subject of the older generation they will be many.

College education gives all that is necessary for the understanding of the principles underlying metallography, but this is not all. A great precipice exists between the work in alma mater's laboratory under the eagle eye of a professor and the brain-breaking problems as from whom to order and how to specify a powder which actually will produce a scratchless

Lucky is the man if the first job which Lady Fortune did bring to him happens to be in a modern, up-to-date laboratory. Alas, there still are in this happy land of ours some places where the good slogan "what was good for our fathers is good for us" holds strong, and the poor personnel suffers from an endless row of unexplainable troubles.

It is mostly for the benefit of the younger members of the profession that the author submits to the readers a detailed description of the procedure adopted as giving quite satisfactory results in his laboratory, but hopes also that it may give some suggestions to anyone interested in metallography and, by helpful criticism aroused, will be inductive to further promotion of quality and simplification of laboratory routine work.

The first operation with which the preparation of a sample begins is the selection of a representative sample of the size convenient for the following manipulations from the object to be examined. This is made on the basis that it must be representative of the features sought.

Wishing to select a sample which would show a desired feature most pronouncedly, one has to use his own judgment, as only a few very general informations can be given. If attention is called to the structure alone, and only a small bar is the object, a cross section will give all data desired, including a possible presence of pipe or segregations. If non-metallic inclusions are of interest the best policy is to polish parallel to the direction of rolling and near the center. Cold rolled steel, wrought iron and forgings will reveal their specific characteristics more pronouncedly when cut parallel to the direction of the last work. If the question arises regarding the nature of seams, rolling laps, forging defects, welds, depth of case, they, self-evidently, must be well represented on the sample. In the above case it is advantageous to polish perpendicularly to the plane in which the defects are located because there is always a chance to miss them if cut otherwise.

Larger size of specimen, of course, will broaden the field of observation, but at the same time considerably increase the difficulty of obtaining a satisfactory finish of the surface. The question is reduced to the problem, how small a sample will fully represent a given feature. For a great majority of cases a polished surface of one quarter of a square inch is ample, and is easy to manipulate. True, it is sometimes necessary to put under the microscope a cross section of a needle or an automobile axle, but for all other work one may recommend to cut specimens of approximately above given area, but in no case allowing any of the dimensions to be less than one-eighth of an inch. If a large surface is to be examined it is better to cut it into smaller pieces than to attempt to prepare for the microscope, say, 4x4 in. square. Though the third dimension of the specimen has nothing to do with the ease of polishing, it is pre-

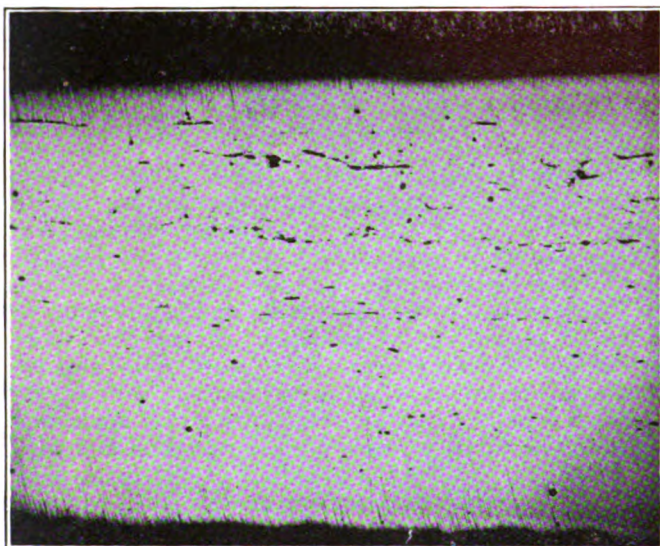


FIG. 1.—Cross section of .030 in. steel sheet. Solder was too cold and did not adhere to the metal. Black hands—interstices between solder and the sheet. Finished on magnesite wheel.

specimen, or how much water to add to it, or some other item of trifling importance, the whole value of which only those who had to solve them themselves could appreciate. The bridge across this chasm is the knowledge of these little, unimportant details, so often acting as demarcation line between success and sad failure. The purpose of this paper is to give them.

For men versed in metallography these details cease to exist. The materials involved are established by a long line of precedents and the mechanical performance comes automatically without any definite thought on the part of the operator, and this is the reason why textbooks, even such splendid works as Doctor Sauveur's, unintentionally do not convey any more details than are necessary for an experienced man.

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ferable to keep it around one-half inch to facilitate its subsequent mounting on the stage.

When the specimen is selected it has then to be separated from the rest of the metal. As a method with the largest scope of usefulness cutting with an abrasive wheel, such as supplied, for example, by Norton Company as $12 \times \frac{1}{8}$ in. or $3/32$ in. 60-3M shellac wheels, can be strongly recommended. They cut fast, have long life and will easily cut any material coming into a steel mill laboratory from ferro chrome down. Hack saws, even power-driven, cannot compare with them because of the limited range of application, slowness of work and unevenness of the surface produced involving some additional grinding. Installation of a cutting wheel will soon pay for itself even in a very small laboratory.

To obtain the best results from a wheel care should be taken not to press the specimen too hard against it. If it takes with the normal pressure, say, one-half inch to cut 15 inches of one-inch plate, all of the former will be gone and the task will not be completed if the pressure is too high. Press as long as there is no smell (excessive heat generated by abnormal friction decomposes the binding medium of wheels) and no grit is flying, only sparks.

The only handicap for the general usefulness of cutting wheels is the size of the objects to be cut. Their maximum dimensions are specified by the opening in the housing in which the wheel is enclosed, but for practical purposes it is inconvenient to cut anything thicker than two or at the most two and a half inches. When an order is received in the laboratory to examine, for example, the center of an ingot measuring 32×32 in. in cross section there is no use to try to handle it without the help of the machine shop which should be instructed to cut a plate of it about one inch thick and not more than 6×6 in. area. The same procedure has to be followed in any case when heavy or bulky objects are to be dealt with.

If some other feature, not the structure, is sought, the specimen can be left on the wheel until it is cut. Though the danger of affecting the structure of a sample, especially a hardened one, is not very great, it still must be minimized by holding the piece with the fingers so as to feel the temperature and to prevent excessive overheating by frequent immersion in water.

Sometimes cutting of a sample leaves it in such a shape or size that some further preparation is needed to facilitate its subsequent handling. Even a very experienced operator will not undertake to polish a cross-section of a piano wire, 30-gage sheet or $\frac{1}{8}$ -in. ball without mounting them first, which means surrounding them with some suitable media and producing thus an article of convenient shape. This is usually done by surrounding the specimen with some kind of a mold and pouring in it an easily fusible metal.

Molds which can be changed to suit a particular occasion seem to be more advantageous than those of permanent shape. If the shape of specimens is liable to vary widely, considerable savings in bulk of the mounted sample as well as a wider range of sizes being taken care of can be effected by adjusting suitably the retaining wall of a mold. A sheet of thin gage steel is cut into strips about $\frac{1}{4}$ or $\frac{3}{4}$ -in. wide and 4 to 6 inches long. It is but of little importance

whether their edges are parallel, but it is advantageous to have one of them as straight as possible to simplify their use, as will be seen later.

A specimen to be imbedded is placed on a flat steel plate with the surface to be polished down. A strip

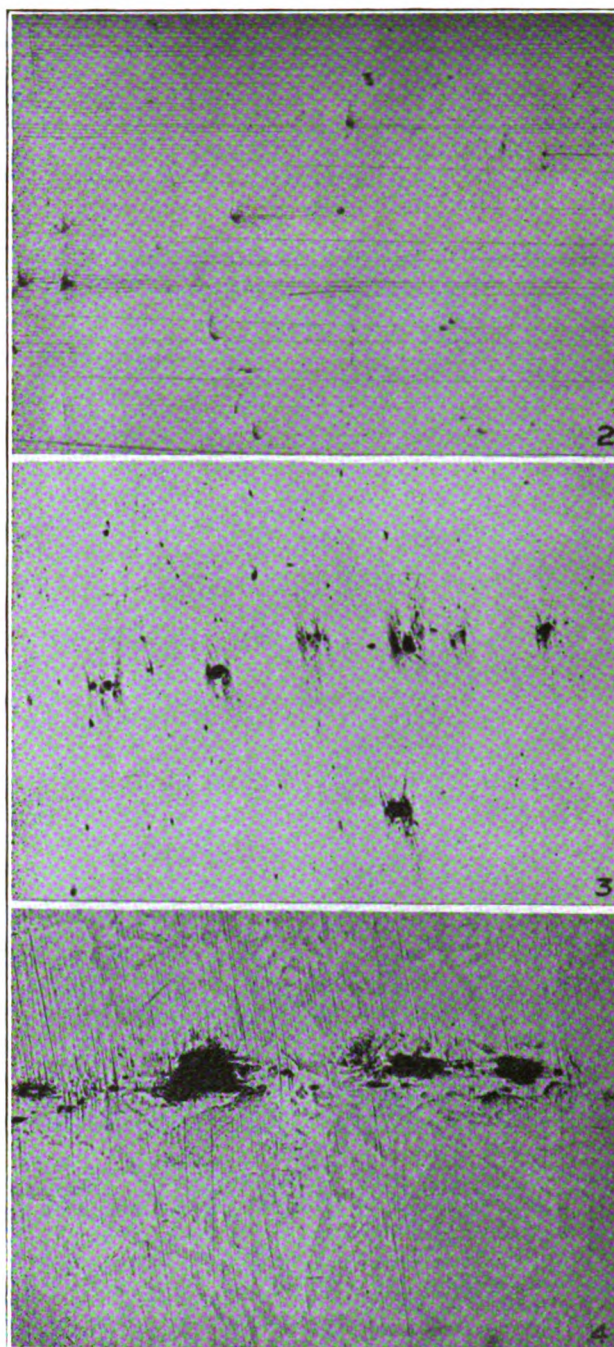


FIG. 2.—Carelessly finished on an old wheel with Norton levigated alumine. No turning at 100 deg. and heavy pressure. The shape of sonines cannot be distinguished. Two particles of dust were not recovered before exposure.

FIG. 3.—Magnesite finish. Sufficient elimination of scratches and satisfactory frequent rotation. Pressure is excessive resulting in deep "tails."

FIG. 4.—Magnesite finish. Too dilute mixture and exclusively slow speed polish. The sample in relief before elimination of the scratches.

of steel is bent to surround it, leaving a clearance of not less than $\frac{1}{8}$ -in. and the ends of the strip are pressed together to close the mold. The straight edge of the strip should be down for the same reason. A

common solder, 50 per cent lead and 50 per cent tin melted in a crucible acts as mounting medium. If the specimen has such a shape as to be able to rest on the bottom plate and is heavy enough not to float under the impact of the stream of molten solder no special precautions should be taken. Otherwise it is necessary to hold it with pincers until the solder sets. One may recommend the addition of the latter in two portions. The first, covering the bottom as a layer $\frac{1}{8}$ -in. deep, serves to hold the specimen in place and to seal the openings around the bottom, through which the metal under hydrostatic pressure is liable to escape. It solidifies almost instantaneously and the mold is then filled to the top.

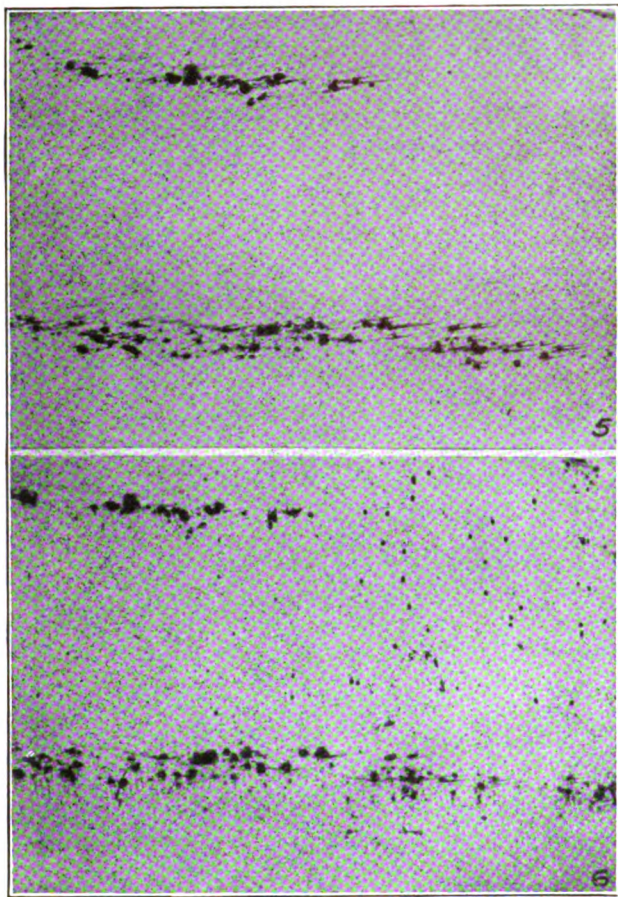


FIG. 5.—Same specimen as Fig. 4 but a different place. Finished with levigated alumine from Central Scientific Company. Reasonable freedom from scratches not too prominent "tails" but finished in the wrong direction.

FIG. 6.—Same spot as Fig. 5 but repolished and allowed to dry between second and last wheels to show the rust formed. Alumine finish.

One-eighth of an inch as minimum clearance was mentioned because it is necessary for proper imbedding. Solder passing between two closely placed metallic surfaces loses its heat and is liable to solidify before the space is completely filled or to become so cold that it does not adhere to the surface of metal close enough to prevent the formation of some interstices in which liquids used in subsequent operation by Hubert. The paper is cut in 12-in. circles and placed on both sides of wheels and the gasket is tightened with a nut. Centrifugal force holds the paper perfectly flat. Usually about 10 sheets of each grade are put on wheels simultaneously. When a sheet is worn out, i. e., does not polish fast enough, it is torn

are liable to collect and oxidize the nearby areas. For the same reason it is better to mount separate sheets than a bundle formed by placing several of them together.

Though mounting of quenched steels ought to affect slightly their physical properties, the structure may be safely considered as unaffected due to low temperature and a brief interval of time during which it is applied.

Cutting usually leaves the specimens covered with many deep scratches which are removed on a grinding wheel. As quite suitable for this purpose alundum wheels furnished by Norton Company as 12x1-in., grain from 36 to 46, grade M, may be used. They are rough enough to cut fast but uniform in texture, so as not to mark the specimen with deep and ununiform scratches. Finer grain size should be avoided. The sample is pressed with fingers towards the flat side of the wheel and often immersed in water to prevent dangerous overheating. General rule is to turn a specimen at 90 degrees to the direction of marks left by the preceding operation, though very helpful and always followed sometimes has to be abandoned in the case of the roughing wheel. Specimens which are to be examined for non-metallic inclusions always have to have the direction of final polish perpendicular to the direction of rolling, and therefore it is sometimes unavoidable to hold the specimen in the same position on cutting and roughing wheels. The grinding is finished when the scratches are of the same depth and run in the same direction. When the edges of specimens are of no particular value, they may be advantageously rounded here to prevent the possibility of cutting the cloth on wet wheels.

Paper wheels, which are the next step of preparation, consist of four grades of emery paper mounted on flat wheels 12-in. diameter and rotating in vertical plane. The wheels are not encased in housings. One stand with two wheels and a motor running at 1100 rpm. serves for the whole set. The grades of paper mentioned in order used are: No. 1, G, 1M and O or 1F. Three last are made in France off and a fresh one is ready. As a time-saver this arrangement is to be highly recommended, though it has a slight drawback, perceptible rounding of the edges. In a great majority of cases it may be disregarded, but interferes with the work when the periphery of a sample has to be examined under high magnification. In the latter instance it is better to imbed the specimen anyway.

The sample is firmly held with the fingers and pressed against the wheel. The direction of polishing should be at the right angle to the scratches left by the rough wheel. The first paper, the coarsest, needs more time and attention than any following. All previous marks should be eliminated here. Almost always the time consumed on this wheel is long enough to overheat the sample and cooling in water is necessary. After immersion the specimens should be dried in order not to spoil the wheel with the moisture. When all scratches on the surface run in the same direction the specimen is transferred on the next grade of paper, turning it, as usual, at 90 degrees. Only a few seconds are needed to remove the previous marks on any of the subsequent wheels even when the pressure is slight, as it should be here.

Wet wheels, the next operation, will give more troubles than all others combined if certain precau-

tions are not observed. Their purpose is the total obliteration of all divergencies from a perfect plane needed for microscopic work. Very fine grades of paper, especially those which have been worn already, will produce a flat surface almost free from scratches, but their use is to be discouraged due to burnishing action distorting the actual structure. Wet wheels should be as free from this objectionable feature as possible. This is achieved by the use of soft backing on which the abrasive is carried and moderate speed. The best grades of broadcloth are the common material for backing.

A set of vertical spindles on which easily removable horizontal wheels 10-in. diameter are mounted is placed in a row inside of respective housings provided with covers. Probably located shaft and belting connect them with a common motor and the pulley ratio is calculated to run the wheels at 500 rpm. This arrangement can be placed on a separate table as it is shown on the accompanying photograph.

Selecting the material of which the wheels are to be made, it is necessary to keep in mind that wood, even chemically treated to make it water-proof, is lacking in sufficient hardness, so that after some use the surface of the wheel will be far from a true plane, firstly due to the abrasive action on wood, and secondly to the fact that comparatively rough surface of the wood results in accumulation of unevenly distributed masses of powder under the cloth. Metal wheels are subjected to corrosion which often is not uniformly distributed, especially on the zinc wheels, which after a few days in service become covered with little clusters of rust of quite an appreciable height. They, protruding through the cloth, scratch the specimens badly and the longer polishing results not in improving but in total spoiling of the surface, though the powder on which the blame is usually directed in such a case is not at fault.

Any wheel can be vastly improved by interposing between it and the cloth a disc cut of glass to fit its shape. Ordinary window glass is suitable, but to minimize the breakage due to inevitably occurring shocks when a specimen "catches" the cloth double thickness or, better, plate glass can be recommended. There is no special need for fastening the disc with some waterproof glue, but for safety sake it does not hurt. In our practice the dampened cloth stretched over the disc and kept in place with rubber bands holds the same fast enough to suit any safety man. The centrifugal force is well balanced and three or four rubber bands of the kind used in offices are quite sufficient.

The cloth as received from a store is free from grit for practical purposes. It should be cut into squares with sides about two inches longer than the diameter of wheels and stored in a place protected from dust. When a wheel is worn out, i. e., torn on coarser or becomes too gritty on the last one, it is removed from the housing, rubber bands lifted and the cloth thrown away. The wheel is held in a vice by its hub, the glass washed clean from any adherent powder, replaced, covered with a square of cloth and the rubber bands are put around it so as to fit the groove on the side of the wheel. By pulling at the edges the cloth is smoothed and then trimmed with shears, leaving a border about half inch wide. After this it is placed on the spindle, wet with water and is ready to receive powder.

A powder to be conveniently applied to a wheel must be suspended in some liquid. As a container for this mixture an ordinary wash bottle of about 1,000 cc. capacity and of the kind used in chemical laboratories hardly can be surpassed. It permits to have a comparatively large amount of mixture ready for immediate use, well preserves it from contamination with dust and makes the application to the cloth even using one hand, very simple.

To prepare it, enough powder is placed in the bottle to fill it to about one-eighth of its capacity for coarser wheels and half of this amount for the final, the bottle is filled with liquid, shaken vigorously and the mixture is ready for use.

Three grades of powder are sufficient to prepare a sample. For the first stage is selected XF alundum manufactured by Norton Company, for the second levigated alumina of the same make, for the last "Magnesite" polishing powder furnished by Henry A. Goldwynne, 26 Cortland street, New York, or levigated alumina from Central Scientific Company.

Water is used as carrier for first two powders. If levigated alumina is preferred for the last wheel it is mixed with the amount of water indicated on the container in which it is sold; if Magnesite, the water has to be substituted with some other substance not acting chemically on this powder. The change from orthodox water to, say, benzol, was made because the elimination of the former permits to use a very slight pressure, maximum dilution of powder and thus to carry the elimination of scratches as far as wanted, far above the requirements of routine work, if necessary, without the slightest danger of oxidation.

Benzol is selected as a carrier only because the mill store room has a large supply of it at hand and, of course, any similar liquid is quite satisfactory.

The wheels are always kept covered. The lid is removed from the first one when a sample is ready for it. The cloth is moistened with a handful of water, and some powder, after shaking the bottle, is squirted on it so as to cover uniformly the whole surface. This is done when the wheel is running. The specimen is put on the side of the wheel which is going from the operator and, to prevent the possibility, though very small on a flat wheel with glass backing, of tearing the cloth, the back part of it is lowered first. It is safer to place the specimen near the center and then to move it outwards. Some more powder is added while the polishing proceeds and the operation is continued until all preceding scratches are eliminated.

The sample and fingers are washed in running water, the first wheel covered with its lid and the polishing, after turning at 90 degrees, is continued exactly in the same way on the second wheel as on the first.

Sometimes when several specimens are to be polished at the same time all of them are run on one wheel and then on the other. This practice should be strongly discouraged. If samples are dried between operations no savings in time are effected. If left wet, the rust inevitably forms as little specks which need much time for their removal on last wheel and are once in a while mistaken, under cursory examination, for sonims.

The preparation of a specimen for visual examination terminates, unless etching is necessary, with

They not only badly spoil the appearance of specimens, but, what is more important, camouflage to a certain extent the real shape of inclusions. Though some reduction of these scratches can be obtained by frequent turning of specimens while on coarser wet wheels at 180 degrees, they cannot be completely eliminated, and the only means left when the sharp definitions of inclusions is important lies in the use of the last wheel. Very light pressure and thinness

The greatest scope of routine work can be covered when the etching is needed by the use of picric or

Serial No.	Date	Customer	Home	Type	Purpose	C	J	S	P	S	G	N	V	Brinell	PM	Description	Remarks
E 89	9-20	Alfa Romeo Racing C	1757	1001005	Stainless Steel bar											Chips from ballballs	Material for reflecting g. 10000 High speed steel made
E 90	"	Bowditch Moller	2119	2AK	1/2 inch dia	.26					1.07			214	138000	1/2 inch dia in 10000	Out of spec. for spec. for 10000 10000, but may cause g. 10000
																	Not a standard in spec. for 10000 10000, but may cause g. 10000
E 91	9-22	Chrysler Buff. Off. C	2	-	1/2 inch dia	.26	10	0.57	0.17	.17	1.21	4.48	10000	415	140000	1/2 inch dia 10000, 9000 spec	High speed steel. 10000 10000, but may cause g. 10000

To facilitate drying the use of alcohol is recommended. Grain, pure or denatured, or wood alcohol (methanol) can be successfully employed for this purpose. Commercial grades, about 96 per cent strength,

Some practical experience is required for correct estimation of the proper degree of attack. As a very

sketchy description of the desired intensity of etching one may say that the action of the acid should be stopped as soon as the bright surface of the specimen becomes dull and is colored light, even gray. Blackish or brownish tints indicate overetching.

When the desired shade is reached the specimen is held for a few seconds under a stream of water, the water is shaken off(the specimen immersed in two successive alcohol baths and then is dried with an air blast or with a piece of soft cotton cloth by pressing it gently on the surface without rubbing.

To have the prepared surface perfectly parallel with the plane of the stage, or perpendicular to the optical axis of the microscope is the principal requirement for mounting a specimen before placing it on the stage. A magnetic specimen holder is very convenient at times but its usefulness is handicapped by the impossibility of observation of the whole polished surface without resetting and the troubles encountered when large, especially mounted, specimens are to be examined.

A brass pipe about inch and a half diameter is cut on a lathe into $\frac{1}{2}$, 1, $1\frac{1}{2}$ in. lengths. Some of them are flattened on the sides so as to accommodate longer specimens. It seems to be not far from true that these three size will take care of all specimens coming into a laboratory with a very few exceptions. As a base for the mounts a plate of heavy glass cut into strips of about 1 in. x 3 in. to fit the stage is used. For mounting medium, nothing is found to excell moulding wax of the kind which can be bought in 5 and 10 cent stores because it does not change its plasticity under the influence of temperature.

The specimen is placed face down on a piece of clean paper, a suitable size of pipe is selected, a small lump of moulding wax is fastened by pressure to the glass plate and the pipe is put in such a position as to surround the specimen. The base plate with wax adhering to it is turned upside down and pressed on the specimen until the former is well imbedded and the plate rests on the walls of the pipe. There is no need to have the pipe around the mounting and therefore it is removed, the polished surface wiped from dust with a camel hair brush and the specimen is put on the stage.

When an abnormally large sample has to be examined it is better to imbed it by hand, omitting pipe and to correct the deficiency in mounting by a frequent refocusing rather than to keep in stock excessive sizes of pipe lengths just for such rare occasions.

Preparation of specimens for microphotography does not involve any mounting if inverted type of microscope is used, or is similar to the described above with an ordinary kind. In the first case the object is placed face down on glass plate provided on the stage and is ready for focusing unless its size is smaller than the opening in the plate. In this occasion a magnetic holder can be used to advantage. By laying it on the stage a convenient support is formed for almost any size of specimens on which they are held in the same position as on the glass plate. Specimen holders of spring type cannot be recommended because only very seldom the polished surface forms a true right angle with the sides of the specimen and the pressure of the spring inevitably

will hold it at any other than 90 degrees angle with the optical axis of the apparatus.

Some of the specimens may be needed several months after the first examination, and the question arises how to protect them from deterioration, keep all necessary information complete and easily available and not to lose the identity of a sample.

Specimens examined in a year's time, which seems to be the limit of their usefulness, run into thousands, so that their storage in dessicators will involve a large and unnecessary outlay of space and money. Unnecessary because though some specimens may happen to be of great interest some time after the examination the great majority never will be used again, and it is simpler to repolish and reetch one when needed than to keep thousands ready for microscope. There is a way of eliminating the dessicators and still having the specimens well preserved, lacquering, but it has its drawbacks. Though some of Du Pont cellulose acetate and nitro-cellulose lacquers produce after a single immersion and air drying a water-proof and totally, even under higher magnifications, invisible coat, the samples thus treated require careful handling because the lacquer being soft is very easily scratched.

A filing cabinet of the kind used in drafting rooms for blue prints can be used as convenient storage place. Its drawers are large enough to permit the installation of wooden partitions, each to accommodate ten samples, usually nine in a row and as many rows as the size permits, and are shallow enough to avoid the unnecessary waste of room.

Specimens are marked in numerical order and are placed in compartments so that each row holds 99 specimens. As almost always the size of specimens is large enough to have space for at least three figures the use of a letter prefix and numerals from one to 99 will easily take care of the yearly supply of samples.

Stenciling, though rather troublesome, does not give any special benefit and should be replaced by writing with india ink directly on specimens as being more versatile, dependable and convenient.

The lack of instantaneously available information will reduce the whole mass of specimens carefully stored to something not much more in value than an equivalent weight of scrap iron. Every sample as soon as it is examined is entered in a log book under a given number. It is then written on the sample itself. The log book should approach bookkeeper's ledger,—with the least amount of writing to record the maximum volume of informations.

Attempts to devise a log book well suited for any laboratory in the universe will be, of course, futile as well as foolish, but as a first approximation may be suggested the form given below and found satisfactory for an ordinary steel works laboratory.

Mr. W. L. Schreck, who recently resigned as chief engineer of the Wheeling Steel Corporation to enter business for himself as general consulting engineer, with offices in Wheleing, W. Va., is now in Europe. Mr. Schreck will visit many of the most important iron, steel and mining districts of continental Europe and will return early in the spring of next year.

Gas Producer Theory and Practice

Beginning of a Series of Investigations Dealing With the Important Phases of Producer Operation

By A. B. HUYCK*

PART I.

WHILE the development of improved gas producers has been very rapid of late years the fact remains that steel plant practice is still on a much lower level than it should be. The improvement in the practice has not kept step with the improvement and development of the producer itself. There are of course many old style producers in operation where good practice is extremely difficult but it is too often a fact that when new up-to-date machines are installed old methods are continued and little improvement results so far as the efficiency of the process is concerned.

Object.

In the consideration of a subject of this kind there is very apt to be a clash between the theorist and the practical man which makes it hard to get on common ground and work out means for improving practice. The gas producer problem seems to present more difficulties on this account than many others and for this reason this article is written with the idea of combining theory and practice in the proper proportions to make it of the greatest value possible. It must be remembered however that there are so many types of machines in use under different conditions and using different grades and kinds of fuel that it is almost impossible to make definite general statements. In the following there are a few minor theoretical discrepancies which are allowed for the sake of simplification.

The First Producer.

The first gas producer was simply a shaft with a top and hopper, through which coal was charged and a grate at the bottom through which air entered. This was very unsatisfactory on account of clinker trouble and steam was introduced with the air thereby reducing clinkering. With the exception of the grates which have been done away with, this is the general form of the gas producer today.

Characteristics of Gas Making Fire.

The gas made in this producer may be very good or very bad depending on several conditions. We will assume that we have a good gas making fire. It consists of three layers or zones. The ash zone is at the bottom and is cold from the incoming steam and air which are passing through it from the blast hood. The fire zone is hottest just above the ash and gradually gets colder as we travel upward until we get into the third zone of green fuel on the top of the fire.

Gas Formation.

The theory of the gas formation may be divided up into three parts. First we will consider the formation of carbon monoxide (CO). At the hottest portion of the fire just above the ash the oxygen (O₂) in the air comes in contact with hot incandescent car-

bon and combines with it forming carbon dioxide (CO₂) in accordance with the chemical equation $O_2 + C = CO_2$, liberating a great amount of heat which accounts for the high temperature of the fire at this point. This carbon dioxide (CO₂) in passing on up through the fire then picks up carbon from the hot coke in accordance with the chemical equation $CO_2 + C = 2CO$. This completes the formation of the carbon monoxide which is from 24 to 28 per cent of good producer gas.

Decomposition of Moisture.

Second we will consider the decomposition of the moisture from the steam brought in by the blast. The heat of the fire breaks the water up into its two component parts, hydrogen (H₂) and oxygen (O₂) expressed chemically $2H_2O = 2H_2 + O_2$. The oxygen (O₂) goes to help the oxygen of the air in the formation of carbon dioxide (CO₂) while the hydrogen appears in the gas generally to the extent of about 12 per cent.

Distillation of Green Coal.

This brings us to the last sub-division of the gas formation which is the distillation of the coal in the top of the fire. This is simply the result of the heat coming up from the fire and distilling or driving off the volatile matter in the green coal in the form of methane (CH₄), ethelen (C₂H₄), etc. There is generally about 3 per cent of these gases in producer gas.

In addition to these gases the formation of which we have just covered and which are the combustible gases we have in producer gas some carbon dioxide (CO₂) which has not been reduced to carbon monoxide (CO), a small amount of oxygen (O₂) which has not been utilized and a large amount of nitrogen (N₂) brought in by the air. A typical analysis of very good producer gas, per cent by volume, would be:

CO ₂	C ₂ H ₄	O ₂	CO	CH ₄	H ₂	N ₂
4.8	.4	.3	26.3	3.0	12.0	53.2

Fire Bed Conditions.

The formation of good gas depends entirely on the condition of the firebed. By the condition of the firebed is meant the thickness, temperature and density of its different zones and the absence or presence of holes or channels.

The thickness of the fire is very important. As far as the ash layer is concerned enough ash is necessary to fully protect the blower top and base ring casting and to keep the fire up in its proper position in the producer. The depth of the incandescent zone should be deep enough to give the carbon dioxide formed plenty of opportunity to pick up carbon from the hot coke as it passes up through the fire to form carbon monoxide. It is not possible to say just how thick a fire it is worth while trying to carry but it is certain

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that 12 inches or more possibly up to two or three feet of incandescent coke is advisable. The depth of the coal layer should be enough to keep the gas temperature down to a point where hydro carbons are distilled and driven off and not broken up into hydrogen and soot and also to assure the fire plenty of fuel on the top to take the place of that burned out at the bottom. If a good coal layer is not carried it will be found impossible to build up a fire with any depth. Usually from eight to 24 inches of coal is advisable.

The firebed and coal layer should be of such a density that not too much opposition is offered to the issuing gas and yet plenty of surface is exposed for chemical action and distillation. It is largely governed by the quality and size of the coal. More will be said in regard to this when the coal is discussed.

The important point so far as firebed temperatures are concerned is as high a temperature as possible in the incandescent zone so as to facilitate the chemical reaction. This is limited by clinker formation and is controlled by the proportion of steam in the blast.

As it is a practical impossibility to keep a fire in a perfectly homogenous condition the natural tendency is a formation of holes and channels in certain portions of the firebed where for some reason there is less resistance to the blast. A hole or channel is then simply a fissure or crack in the bed through which the blast rushes since it is the path of least resistance. A great proportion of the blast will seek this hole with the result that enough oxygen is supplied to burn and not gasify the coal around its sides. Also it robs the rest of the fire of blast and so cuts down the gasification in the other sections. The result is always a high temperature in the blow hole which melts the ash and forms clinker.

This tendency of forming cracks and holes has been the gas man's chief source of trouble and much of the late development in gas producers has been made with the idea of overcoming this tendency. A bad blow hole in an otherwise good fire will quickly destroy the quality of the gas.

Agencies Affecting Firebed Conditions.

Necessarily the development of improved gas producers has practically all been along the line of working out means for keeping the firebed in good gas making condition with the use of a minimum amount of hand labor. In the modern producer these firebed conditions are affected by six different agencies, the characteristics of the coal, the coal distribution, mechanical agitation or leveling, blast distribution, blast mixture and ash removal.

The characteristics of the coal supplied a gas producer have everything to do with its operation. The ideal fuel is a high volatile coal with low ash and sulphur, free from fines or slack, lumps to be from $\frac{3}{4}$ to 4 inches across. Manufacturers differ to a small extent on the size lumps they advise for their respective machines but in general that covers the matter. If the lumps are larger than that the firebed is not compact enough, there is too much open space between lumps and not enough surface is exposed for rapid action. If the lumps are too fine the fire is too dense, the green coal cakes and gums up over the top of the fire choking the blast, cutting down the gasification and making high blast pressures necessary. This high pressure tending to burst through in spots causes extensive formation of blow holes and clinkers.

A coal well above 30 per cent volatile matter gives the best results in the producer. The amount of hydrocarbons in the gas depends upon this quality. Low sulphur and ash mean a minimum of clinkering. The amount of sulphur in the coal or rather the ratio between the sulphur and ash is the governing factor, complicated at times by large proportions of iron. If we have a great amount of sulphur in proportion to ash it may be necessary to blow such a large proportion of steam in order to prevent clinkering that the capacity and gas quality may be seriously affected by the lack of oxygen and the cooling of the firebed. For this reason often times in practical operation the clinkers are tolerated by putting more labor on the producers.

There are so many grades of coal used in producers that it is impossible to give any set rules for governing operation. What can be done with one grade cannot be done with another and the only way to find out how near ideal operation can be approached is to make a study of that particular grade as it is gasified under practical operating conditions. With poor grades of coal or slack it is impossible to carry as heavy a fire as with good coal.

Coal Selection.

In the selection of a coal we are governed by what is available and the price as well as by how a producer will handle it. In coming to a decision on what coal should be used a thorough study must be made of all these factors of the case. In this connection there is one point which should be mentioned and which is a considerable item. With a poor coal the higher gas temperatures necessary result in much more wear and tear on producer parts, gas mains, reversing valves, dampers, etc., so that a producer operated on good coal will have a much lower cost of maintenance and will aid considerably in lowering a part of mill maintenance.

If in the planning of a gas producer installation, enough units are decided on to take care of the requirements on good coal and at some later time the original idea is lost sight of and poorer coal is used in an attempt to cut down cost very often the saving in fuel is more than offset by the troubles in the mill due to poor gas. In other words if in order to use poor coal it is necessary to force the gas house to the limit, mill and gas house trouble alone will probably offset the saving in coal cost not to mention the decreased efficiency of gasification.

Generally speaking there is little doubt that better coal means better economy so far as the gas house is concerned.

Coal Distribution.

The distribution of the coal as it comes down on the fire should be uniform. That is it should cover the top of the bed evenly and not pile up in certain places. If it does pile up in certain parts of the firebed and is not barred around by hand the fire is coked and gummed up in those places and blows through at others forming channels and holes resulting in poor gas and a waste of coke in the ash as well. It would seem that a producer which sprinkles the whole firebed rather than drops coal on one side as the fire revolves would have the advantage so far as coal distribution is concerned.

It is not only necessary that we have a uniform layer of coal on the fire but that we keep the layer

a constant thickness in order to keep a uniform gas temperature and quality. To do this we must have a control with which we can regulate the supply putting in fresh coal at the same rate that the fire burns out at the bottom so keeping the layer at a constant depth even with a varying amount of blast necessitated by a varying demand for gas.

At the time any quantity of coal is dropped on the fire we get a puff of rich volatile matter. For this reason the coal should be fed continuously and not dropped on at intervals.

Producer manufacturers all put automatic feeds on their producers except in cases where the installation is small or where overhead bins are not possible. They do this because by so doing they can approach the conditions just enumerated and also because it cuts down the amount of hand labor necessary to feed the machines.

Mechanical Interference With Fire.

In regard to mechanical interference with the fire there is not much to say other than to give a description of the different methods. When two different builders of producers absolutely disagree as to the theory of proper agitation and yet both build excellent machines that give very good performance there is little use in indulging in much theoretical discussion of the subject.

The purpose of this interference is to keep the fire uniform and homogeneous and free from blow holes thereby keeping the gas quality good, eliminating clinkers and keeping up the possible high rate of gasification.

Of the four concerns who build producers in any numbers two agitate the firebed, one levels it and one both agitates and levels. While there is of course disagreement among them as to the value of their respective schemes, the fact remains that the purpose is the same and that they all accomplish it very well.

A description of the different methods of agitation will be given later.

Blast Distribution.

The distribution of the blast should be such that there is no tendency to blow through in certain parts of the fire. A good many different forms of blast hoods have been tried out, some of them with as many as five or six steps. The forms used in modern producers are relatively simple being of a two or three step form determined by experiment to give good distribution. Some of the simple single mushrooms seem to give as good results as the five or six step tops.

The proportion of air and steam in the blast is or should be governed by the amount of clinker formed. Enough steam should be blown to prevent the formation of clinkers by cooling the fire to a temperature lower than the melting point of the ash. The poorer the coal the more steam will be necessary. Not enough attention is given this part of producer operation. Too often trouble with clinkering could be completely overcome by intelligent blast regulation. It is important however not to shut off the air to the extent of lowering the capacity of the producer. The only way to find out the proper air slide setting is by trial.

Ash Removal.

The ash removal has been the subject of considerable experimenting and investigation. There are two

methods of removing ash, the periodic and the continuous. The periodic is done sometimes by hand and sometimes mechanically at intervals of 12 or 24 hours or some longer time while the continuous is always mechanical. The development has been along the lines of continuous ash removal for two reasons, first because it in connection with good agitation eliminates the cleaning period when the fire is badly torn up and gas making very much interfered with and second because it cuts down the labor necessary which was used for breaking down the fire and shoveling out the ashes.

A good continuous ash removal is a great help to agitation since it keeps the fire at a nearly constant height. If the removal is periodic there are times when the fire is too high or too low to be properly agitated unless the agitator travels up and down with it. If the agitation does not keep the firebed worked down as the ashes are removed the continuous removal may not be an advantage as the fire will arch until broken down by hand. One producer builder in developing a device for continuously removing ashes found that the firebed was agitated considerably from below and claims that this is a distinct help in keeping it in good condition.

Summation.

Of course it is too much to expect that any one make of producer would embody all the good points of producer design and be an ideal machine. Nevertheless the modern producer gas machine is an excellent piece of apparatus and will gasify good coal very efficiently if properly operated.

Machines on the Market.

The four makes of mechanical gas producers on the market are Wood, Morgan, Chapman and Wellman or Hughes. All of them are automatically fed, agitated or leveled and have mechanical ash removal.

The R. D. Wood type of producer is manufactured by two different companies, in two slightly different forms. The agitation is accomplished by two vertical stirring arms set at different distances from the axis of the producer. They are curved and rotate on their vertical axis. They in conjunction with the rotated fire cause the agitation. Both turbo and steam jet blower are supplied. The ashes are continuously removed. Greater capacity is claimed for this producer than for any other. It is also claimed that it will gasify slack coal very satisfactorily and at a high capacity.

The Morgan Producer is distinctive with respect to its leveling device. Its builders claim that the fire should not be agitated but should be leveled only and have proceeded on that hypothesis. A leveling bar is suspended from the top and drags over the top of the firebed as the fire revolves leveling it and filling any holes that may form. The builders also claim an improved blast distribution by the use of three radial arms set 120 deg. apart with a blast outlet in each. The ash removal is periodic.

The Hughes or Wellman producer is the original mechanical producer so far as this country is concerned and is probably best known. The agitation member is a heavy poker which hangs from the top and oscillates back and forth as the fire revolves. The ash removal is periodic. Turbo blower is supplied if desired. In the latest design of this machine some changes have been made that increase its capacity and make the ash removal continuous.

The Chapman producer differs in several respects from any of the others. The agitation is accomplished by a floating tube in the form of a rake. This rake rotates and is intended to operate just under the top of the fire. The distinctive features of this method of agitation are the motion of the agitator up and down with the fire and the speed of rotation allowable on account of rotating the agitator rather than the producer shell as in the other makes. The ash removal is continuous and also acts as firebed agitation from below. The top and agitator are applicable to old producers and have the advantage of changing an old type produced into a modern one so far as agitation and coal feed is concerned, at a relatively low cost.

Capacity.

The matter of capacity has been given much attention in the last few years with the result that great steps have been made. Producer capacities have been increased from 500 or 600 pounds of coal per hour up to 3,000 pounds. One builder claims as high as 4,500 pounds even on slack coal. There is no question but that most producer manufacturers claim greater capacities than the user can hope to get even under intelligent supervision. A great majority of up to date producers in service are being operated at considerably less than 2,000 pounds per hour. Capacities have been increased of late years by increasing the size of shell and increasing the blower capacities which resulted in lowering the first cost of equipment and the cost of operating labor.

Efficiency.

In speaking of gas producer efficiency the thermal efficiency is generally referred to. The thermal efficiency means the heat efficiency. That is the amount of heat delivered from the producer in the gas as compared to the amount of heat put into it in the form of coal, steam, etc. The efficiency of a gas producer is then the amount of heat delivered from the producer in the gas divided by the amount of heat put into the producer. Both these factors are made up of heat in more than one form.

Let us consider these heat values going into and coming from the producer. Going into it we have the heat carried by the coal, by the steam and by the air. Coming from it we have the sensible heat and the heat of combustion in the gas plus a small amount of heat in soot formed. The sources of loss then as far as the producer itself is concerned are radiation of heat which is carried away by air currents and cooling water, carbon lost in the ash and carbon lost in soot.

For the present we will dismiss the ash and soot losses by saying in almost all cases they can be kept very low, about one per cent each, by ordinary operation. The important item then as far as the producer itself is concerned is the radiation loss.

In considering the efficiency of our gas making machine in this way we must not fail to remember that it takes in the producer only. This is only a part of the heat consideration and if the mains are long and exposed it may be the smaller part. We must keep in mind then that the manner in which we run our producer has to do not only with the producer itself but with the conducting system up to the furnace.

As was stated the heat available in the gas as it leaves the producer is in two parts, the heat of com-

bustion or the heat which results when the combustible elements burn and the sensible heat or heat in the gas due to its temperature. The heat of combustion does not change since the gas quality cannot change but sensible heat is lost all along the way to the furnace by radiation. Now the more sensible heat in the gas, the higher its temperature, and the higher its temperature, the more heat is lost by radiation both in the producer and along the main. So to cut our largest loss to a minimum both at the producer and in the main we must operate with a gas temperature as low as possible.

So when we speak of gas producer efficiency we must remember that we are speaking of the producer alone and that a machine of higher efficiency may be operating less economically than one of lower efficiency if it happens to be at a greater distance from the furnace.

There is another phase of the matter which is very important and concerning which something should be said. Authorities agree that in the regenerative furnace a part of the sensible heat in the gas is lost by the resulting increase in the temperature of the waste gas. There is a difference in opinion as to what proportion of it is lost. Campbell says all of it. Surely a part is lost and whether or not all of it does not matter so far as we are concerned, because no matter which is the case, we are given another very important reason for keeping our gas temperatures as low as possible.

The matter of improvement in producer practice then resolves itself down mainly into ways and means for keeping gas temperatures down to the lowest possible point. In the modern mechanical producer it is a simple matter and means only education and supervision of the operators. With the older producers however, it is a difficult problem.

(To be continued.)

1803 — 1924

"Over One-Hundred and Twenty Years of Service"

The above caption, which is used to introduce a very interesting booklet recently compiled and issued by Mackintosh-Hemphill Company of Pittsburgh, evidences the pride of achievement which these hundred and more years of business life have brought, not only to the original founders of one of the best known engineering organizations in the steel industry but also to those successors who have so well carried out the ideals fundamentally laid down.

"The Maker of Pittsburgh,"—so Henry Clay Frick called James Hemphill.

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The truth of this vision was shown when the Steel Corporation was organized.

The booklet is replete with historical data, intimate facts of the remarkable story of steel.

THE SAFETY CRUSADE

Does Industrial Health Work Pay the Employer?

By HELEN LORENZ WILLIAMS*

TO what extent is an employer responsible for the health of his employees? If he assumes responsibility for it, does the expense involved pay a sufficient return in financial profits? If it does not, is it good business? These are questions that confront the employer who looks with skepticism upon the rapid increase in industrial health work and so hesitates to establish it in his own shop or office.

To a certain extent employers nowadays feel responsible for the health of their employees. That is,

for workers who operate dangerous machines or spend the day in an atmosphere laden with mineral or textile dust, safety devices that minimize the danger of preventable accident or illness are installed as a matter of course.

On the other hand, industrial health work as it is understood by business concerns that are conducting it in a much broader way, is expensive; and no firm is engaged in the production and sale of a product for humanitarian reasons only, be they ever so laudable. Which is as it should be.

*National Tuberculosis Association, New York City.



Typical daily scene in an emergency hospital where subjects are examined for incipient stages.

Industrial health work is not merely a sentimental and unnecessary fad, it is an investment. Its success is a sound business success. In this respect, industries that have practiced it the longest are the greatest enthusiasts. While it is difficult to show that it pays large cash dividends, those that do accrue from it are of a more subtle but equally valuable nature. For example, the worker who receives free medical advice and attendance, and possibly nursing service, is loathe to leave his job. In fact, he may even prefer his old job to a new one at a higher wage, but with less security in times of illness. Dr. B. L. Wyatt, formerly Director of Public Service, Laurentide Company, Grand'mere, Quebec, states that other returns from health supervision which have no financial equivalent are, increased production (due to a more cooperative spirit and improved health standards); increased efficiency and decreased operating costs, (due to fewer occupational "misfits"); diminished unjust claims for compensation, (due to careful recording of the physical condition of applicants and employees); improved home and community conditions, (due to health education and other measures); improved relations between employer and employee, (due to the factors of community interest and mutual advantage).

Industrial executives who have had the greatest experience with programs of health supervision are agreed that such results are at least as important as those that show on the books as profits in dollars and cents, although it is generally conceded that the maximum benefits cannot be realized in less than from three to five years. The New York Telephone Company, Metropolitan Life Insurance Company, and the Dennison Manufacturing Company, who have been doing industrial health work for more than a decade, are among the organizations which, by a steady expansion of their program, prove their belief in its efficacy. One of the strongest arguments in favor of industrial health work is the experience of the National Cash Register Company. This corporation has reduced the average loss of time by employees on account of illness to 13 hours per year as contrasted with the United States Public Health Service survey which showed an average for the country of 7 days.

The degree to which the work should be undertaken depends largely on the type of industry and its location. For example, mining companies whose workers live in remote communities far removed from social contact or medical assistance, not only care for the miners themselves, but their wives and children as well. In an office in a large city, on the other hand, the work need not necessarily be so extensive.

Among the chief advantages of an industrial health service is the periodical physical examination. Investigations of one large life insurance company indicate that such examinations have a potential life saving value of \$30.00 each. On the other hand, they are worth as much to the employer as they are to the employee for one reason at least; a worker cannot be efficiently placed unless something is known about his physical condition.

One of the insidious diseases that periodic medical examinations help to control is tuberculosis. The National Tuberculosis Association and its affiliated organizations have for a number of years been ardent supporters of the industrial health idea, as well as

periodic physical examinations for both worker and employer. To carry on this work as well as other phases of the campaign, the seventeenth annual Christmas seal sale will be held throughout the country during December.

An Unusual Career

An unusual career was brought to a close with the passing of Dr. Bruno V. Nordberg, founder of the Nordberg Manufacturing Company, whose death occurred on Thursday, October 30th, 1924.

For more than 40 years he has been closely associated with engineering progress and development in the power and mining machinery fields and his death is a serious loss to that engineering profession to which he was so long an important factor. Dr. Nordberg was recognized in the engineering world as one of the foremost inventive geniuses of his time. As a steam engineer he stood pre-eminent in the period in



DR. BRUNO V. NORDBERG

which he lived. His unusual skill and engineering foresight is shown in special installations found throughout the country and particularly in the mining fields. The machinery which he designed will stand for years as monuments to his ability.

While building up his engineering staff the other important departments of the organization were not forgotten. The same fore-thought and rare judgment were shown in the selection of the various other departmental heads, many of whom have seen years of Nordberg service and have been trained along the sound lines and policies of the founder of the business.

During the last years the burdens of Dr. Nordberg were gradually placed upon younger shoulders. The organization which he had perfected had proved its ability to continue on a sound basis, the foundation for which he had so firmly built.

Bibliography of Manganese Steel

By E. H. McCLELLAND*

(Bibliographies accompany several of the references mentioned below. See the second, eleventh, and twelfth references under Hadfield; the second reference under Hibbard; and references under Burnham, Desch, Hopkinson, Mars, and Ruemelin.)

Books and Periodical Literature.

L'Acier au manganèse, 1908. (In *Le Genie civil*, v. 52, p. 288-290.)

Angerer, V. Designing Manganese Steel Track Work. 1915. (In *Railway Age Gazette*, v. 59, p. 341-342.)

Gives brief history and uses of manganese steel in railroad work.

Armstrong, P. A. E. Manganese Steel Welding. 1916. (In *Electric Railway Journal*, v. 47, p. 1144-1146.) Describes the Strohmenger process for welding manganese steel.

Arnold, J. O., and Read, A. A. Chemical and Mechanical Relations of Iron, Manganese, and Carbon. 1910. (In *Journal of the Iron and Steel Institute*, v. 81, p. 169-185.)

Arnold, J. O., and Read, A. A. Chemical Relation of Carbon and Iron. 1894. (In *Journal of the Chemical Society*, v. 65, p. 788-801.)

Gives analysis of manganese steel, p. 798-801.

Barrett, W. F. On the Physical Properties of a Nearly Non-Magnetisable (Manganese) Steel. 1887. (In *Report of the British Association for the Advancement of Science*, v. 58, p. 610.)

Barrett, W. F., and others. Researches on the Electrical Conductivity and Magnetic Properties of Upwards of One Hundred Different Alloys. 1902. (In *Journal of the Institution of Electrical Engineers*, v. 31, p. 674-732.)

The same, abstract. 1903. (In *Minutes of Proceedings of the Institution of Civil Engineers*, v. 151, pt. 1, p. 498-499.)

Includes 18 varieties of manganese alloys.

Barton, Larry J. Manganese Steel Made in Electric Furnace. 1922. (In *Iron Age*, v. 109, p. 4-8, 109.)

Discusses melting practice for castings, use of manganese steel scrap, deoxidizing with manganese ores, and heat treatment.

Beliaeff, Sergius S. Cored Structure in Quenched Manganese Steel. 1922. (In *Chemical and Metallurgical Engineering*, v. 27, p. 1086.)

Sample quenched in water from 1850° F., was etched with 3 per cent nital to develop its structure.

Bidwell, George L. Beater Rolls and Hydration Problems. 1922. (In *Paper*, v. 30, No. 7, p. 53-54, 56.)

The same. 1922. (In *Paper Trade Journal*, v. 74, pt. 2, No. 15, p. 191, 193.)

Discusses the use of manganese steel beater and washer bars in paper manufacture.

Blue, A. A. Carbonizing Manganese Steel. 1921. (In *Forging and Heat Treating*, v. 7, p. 413-415.)

Deals with the advantages of using higher manganese content in steels for carbonizing purposes.

Blue, A. A. Distortion Produced in Casehardening. 1922. (In *American Machinist*, v. 56, p. 915-916.)

Deals with the effect of casehardening on manganese steel.

Brearley, Harry. Case-Hardening of Steel; an Illustrated Exposition of the Changes in Structure and Properties Induced in Mild Steels by Cementation and Allied Processes. Ed. 2. 1921. Longmans.

Treats of manganese steel, p. 78-79, 144.

Bronson, C. B. Heat Treatment as Applied to Railroad Materials. 1919. (In *Journal of the American Steel Treating Society*, v. 1, p. 336-341.)

Deals with manufacture, heat treatment, and tests of manganese steels.

Burgess, Charles F., and Aston, James. Observations upon the Alloys of Iron and Manganese. 1909. (In *Electrochemical and Metallurgical Industry*, v. 7, p. 476-478.)

Burnham, Thomas H. Special Steels; a Concise Treatise on the Constitution, Manufacture, Working, Heat Treatment and Applications of Alloy Steels; Chiefly Founded on the Researches Regarding Alloy Steels of Sir Robert Hadfield, and with a Foreword by Him. Pitman. 1923. (Pitman's Technical Primer Series.)

"List of papers by Sir Robert A. Hadfield on manganese steel," p. 167-168.

Treats of manganese steel, p. 91-100.

Campbell, Howard. Grinding Manganese-Steel Castings. 1923. (In *American Machinist*, v. 58, p. 783-786.)

Presents some interesting methods and equipment.

Campredon, Louis. Propriétés physiques et mécaniques des aciers extra-doux ou fers fondus. 1890. (In *Le Génie civil*, v. 17, p. 276-277, 358-359.)

Discusses the physical and mechanical properties of manganese steel.

Carpenter, H. C. H., and others. Seventh Report to the Alloy Research Committee: On the Properties of a Series of Iron-Nickel-Manganese-Carbon Alloys. 1905. (In *Proceedings of the Institution of Mechanical Engineers*, v. 69, p. 857-1041.)

Gives a summary of the work of previous investigators, and describes preparation, heat treatment, and chemical, mechanical, and micrographical properties of the alloys.

Carr, Bradley Sayre. Manufacture of Manganese Steel Castings. 1918. (In *Machinery*, v. 25, p. 182.)

Abstract of article in "Armour Engineer."

Cast-Steel Wheel with Manganese Tread and Flange. 1916. (In *Electric Railway Journal*, v. 48, p. 69-71.)

The same. 1916. (In *Foundry*, v. 44, p. 457-460.) Chicago's Experience with Solid and Insert Manganese Special Track Work. 1914. (In *Electric Railway Journal*, v. 43, p. 970-980.)

History of experience in the use of manganese steel, with accounts of individual installations.

Cone, Edwin F. High-Manganese Steel for Locomotives. 1924. (In *Iron Age*, v. 114, p. 824-825.)

Davis, Z. T. Manganese Steel Cutting. 1923. (In *Journal of the American Welding Society*, v. 2, No. 3, p. 31-33.)

Dejean, M. P. Sur la classification des aciers au nickel et des aciers au manganèse. 1917. (In *Comptes rendus hebdomadaires des seances de l'Academie des Sciences*, v. 165, p. 334-337.)

*Technical Librarian, Carnegie Library, Pittsburgh, Pa.

Desch, Cecil H., and Whyte, Samuel. The Influence of Manganese on the Corrosion of Steel. 1914. (In West of Scotland Iron and Steel Institute, v. 21, p. 176-191.)

The same, abstract. 1914. (In Journal of the Iron and Steel Institute, v. 90, p. 386.)

Discusses corrosion of manganese steels in 5 per cent sodium chlorid solution.

Contains a bibliography of 18 references.

Difficulties in the Manufacture of Manganese Steel Castings. 1914. (In Electric Railway Journal, v. 43, p. 1221-1222.)

Diller, H. E. Casting Manganese Steel. 1924. (In Foundry, v. 52, p. 245-249, 298-302.)

Describes method of casting, testing and working.

Diller, H. E. Specializes Manganese Steel. 1923. (In Foundry, v. 51, p. 891-897.)

The same. 1923. (In Iron Trade Review, v. 73, p. 1672-1677.)

Dubois, R. Recherche des causes de la désagrégation du ferro-manganèse exposé à l'air libre. 1901. (In Bulletin de l'Association Belge des Chimistes, v. 15, p. 281-286.)

Discusses the action of weathering on ferro-manganese.

Dupuy, Eugene L., and Portevin, Albert M. Thermo-Electric Properties of Special Steels. 1915. (In Journal of the Iron and Steel Institute, v. 91, p. 306-335.)

Test results made on four special manganese steels, p. 331-332.

Garrison, F. Lynwood. New Alloys and Their Engineering Applications. 1891. (In Journal of the Franklin Institute, v. 132, p. 54-65, 111-129, 223-240.)

Treats of manganese steel, p. 127-129, 223-228.

The same, abstract. 1891. (In Journal of the Iron and Steel Institute, v. 40, p. 302-309.)

Treats of manganese steel, p. 305-306.

George, Howard H. Correct Welding Procedure Retains Qualities of Manganese Steel. 1924. (In Electric Railway Journal, v. 63, p. 611-613.)

Use of arc welding prolongs life of manganese steel special work from one to five years.

Gilbert, N. J. Effect of Certain Elements on the Properties of Steel. 1919. (In Journal of the American Steel Treating Society, v. 1, p. 349-359.)

Compares properties of manganese steels with other steels.

Grard, Charles Albert Marie. L'acier; aviation—automobilisme; constructions mécaniques sanctions de la guerre. 1919.

Deals with the properties, forging, and heat treatment of common and special steels.

Treats of manganese steel, p. 208-211.

Groos, A., and Varinois, Maurice. Traité théorique et pratique de cémentation; trempe, recuit et revenu. Ed. 2, rev. and enl. 1921.

Manganese steel is discussed, p. 33-34.

Guillet, Leon. Aciers au manganèse. 1903. (In Bulletin de la Société d'Encouragement pour l'Industrie Nationale, v. 105, p. 421-448.)

The same, abstract translation. 1904. (In Stahl und Eisen, v. 24, pt. 1, p. 281-285.)

Lengthy article on the mechanical properties, critical points and metallography of manganese steel.

Guillet, Leon. Les aciers spéciaux; préface de Henry Le Chatelier. 2v. in 1. 1904-05.

Includes researches on the structures and physical properties of manganese steel, p. 47-77.

Guillet, Leon. Nouvelles recherches sur les aciers au manganèse. 1904. (In Revue de metallurgie, v. 1, mémoires, p. 89-91.)

Further researches on manganese steels, and states that these steels cannot be used without quenching, as the hardness of troostite-martensite structure is insufficient for practical purposes.

Guillet, Leon. Quaternary Steels. 1906. (In Journal of the Iron and Steel Institute, v. 70, p. 1-141.)

Treats of the constitution, mechanical properties and influence of treatment on manganese steels, p. 6-7, manganese-chromium steels, p. 101-109, manganese-silicon steels, p. 109-114. Contains numerous photomicrographs.

Guillet, Leon. Recherches sur les aciers au manganèse. 1903. (In Le Genie civil, v. 43, p. 261-264, 280-282.)

Hadfield, Robert A., and others. Contribution to the Study of the Magnetic Properties of Manganese and of Some Special Manganese Steels. 1917. (In Proceedings of Royal Society of London, Series A, v. 94, p. 65-87.)

Hadfield, Robert A. Experiments Relating to the Effect on Mechanical and Other Properties of Iron and Its Alloys Produced by Liquid Air Temperatures. 1905. (In Journal of the Iron and Steel Institute, v. 67, p. 147-255.)

Contains a bibliography of 76 references, p. 206-210. Includes consideration of various alloys containing manganese.

Hadfield, Robert A. Heating and Cooling Curves of Manganese Steel. 1913. (In Journal of the Iron and Steel Institute, v. 88, p. 191-202.)

Hadfield, Robert A., and Friend, J. Newton. Influence of Carbon and Manganese upon the Corrosion of Iron and Steel. 1916. (In Journal of the Iron and Steel Institute, v. 93, p. 48-76.)

Considers manganese steel.

Hadfield, Robert A. Iron Alloys with Special Reference to Manganese Steels. 1893. (In Transactions of the American Institute of Mining Engineers, v. 23, p. 148-196.)

Hadfield, Robert A., and Hopkinson, B. Magnetic and Mechanical Properties of Manganese Steel. 1914. (In Journal of the Iron and Steel Institute, v. 89, p. 106-137.)

Hadfield, Robert A., and Hopkinson, B. Magnetic Properties of Iron and Its Alloys in Intense Fields. 1910. (In Journal of the Institution of Electrical Engineers, v. 46, p. 235-306.)

Discusses magnetic properties of alloys in general, p. 253-258, and iron manganese alloys, p. 263-269.

Hadfield, Robert A., and others. Magnetic Mechanical Analysis of Manganese Steel. 1921. (In Proceedings of the Royal Society of London, Series A, v. 98, p. 297-302.)

The same, abstract. 1921. (In Journal of the Iron and Steel Institute, v. 103, p. 462.)

Hadfield, Robert A. Manganese-Steel Rails. 1914. (In Transactions of the American Institute of Mining Engineers, v. 50, p. 327-339.)

The same, abstract. 1914. (In Engineer, v. 118, p. 564.)

Hadfield, Robert A. Manganese-Steel, with an Abstract of the Discussion upon the Papers; ed. by James Forrest. 1888. Institution of Civil Engineers.

Treats of manganese in its application to metallurgy.—Some newly discovered properties of iron and manganese. Reprinted from the "Minutes of proceedings of the Institution of Civil Engineers."

- Hadfield, Robert A.* On Manganese Steel. 1888. (In Journal of the Iron and Steel Institute, v. 33, p. 41-82.)
Gives history, manufacture and properties of manganese steel. Contains a bibliography, p. 76-77.
- Hadfield, Robert A.* Results of Heat Treatment on Manganese Steel and Their Bearing upon Carbon Steel. 1894. (In Journal of the Iron and Steel Institute, v. 45, p. 156-180.)
"Bibliography," p. 177-180.
- Hall, John H., and others.* Heat Treatment of Cast Steel. 1920. (In Transactions of the American Institute of Mining and Metallurgical Engineers, v. 62, p. 353-396.)
Treats of high-manganese carbon steel, p. 381-388.
- Hall, John H.* Manganese Steel. 1915. (In Journal of the Society of Chemical Industry, v. 34, pt. 1, p. 57-60.)
- The same.* 1915. (In Journal of Industrial and Engineering Chemistry, v. 7, p. 94-98.)
- The same, condensed.* 1915. (In Foundry, v. 43, p. 138-139.)
Discusses properties, manufacture, moulding, etc., of manganese steel.
- Hall, John H.* Manganese Steel Castings. 1913. (In Iron Age, v. 91, pt. 1, p. 712-713.)
Treats of foundry methods and heat treatment.
- Hall, John H.* Pearlitic and Sorbitic Manganese Steels. 1922. (In Iron Age, v. 110, p. 786-788.)
Treats of castings of about 1 per cent manganese, some of the literature on the subject and their heat treatment and properties.
- Hand, S. A.* Manganese Steel and Methods of Machining It. 1921. (In American Machinist, v. 54, p. 43-45.)
Discusses briefly the heat treatment and methods of grinding.
- Harbord, Frank William, and Hall, J. W.* Metallurgy of Steel. Ed. 7, rev. 2 v. 1923. Griffin. (Metallurgical Series.)
Treats of manganese steel, v. 1, p. 400-403.
- Hibbard, Henry D.* Discovery of Manganese Steel. 1922. (In Blast Furnace and Steel Plant, v. 10, p. 450.)
- The same.* 1922. (In Brass World and Platers' Guide, v. 18, p. 339.)
- The same.* 1922. (In Iron Trade Review, v. 71, p. 39.)
Research Narrative No. 35, of the Engineering Foundation.
- Hibbard, Henry D.* Manufacture and Uses of Alloy Steels. 1915. (In United States Bureau of Mines. Bulletin No. 100.)
Treats of manganese steel, p. 22-34.
"Bibliography," p. 34-36.
- The same.* 1916. (In Railway Review, v. 58, p. 281-284, 304-305, 345-346, 371-375, 680-683, 840-844.)
Manganese steel, p. 371-375.
- Heat Treatment of Manganese Steel. 1924. (In Engineering, v. 118, p. 411.)
- Hilpert, S., and others.* Ueber die magnetischen Eigenschaften von Nickel und Manganstaehlen. 1912. (In Stahl und Eisen, v. 32, pt. 1, p. 96-104.)
- The same.* 1912. (In Zeitschrift fuer Elektrochemie, v. 18, p. 54-64.)
- The same, translation.* 1912. (In Journal of the Iron and Steel Institute, v. 86, p. 302-310.)
Discusses the influence of heat treatment on magnetic properties of manganese steels.
- Hopkinson, B., and Hadfield, Robert A.* Research with Regard to the Non-Magnetic and Magnetic Conditions of Manganese Steel. 1914. (In Transactions of the American Institute of Mining Engineers, v. 50, p. 476-500.)
"Bibliography," p. 494-497.
- Howe, Henry M., and Levy, Arthur G.* Are the Deformation Lines in Manganese Steel Twins or Slip Bands? 1915. (In Transactions of the American Institute of Mining Engineers, v. 51, p. 881-896.)
- Howe, Henry M.* Heat-Treatment of Steel. 1893. (In Transactions of the American Institute of Mining Engineers, v. 23, p. 466-541.)
Presents results of experiments on toughening manganese-steel by sudden cooling, p. 467-476.
- Howe, Henry M.* Manganese-Steel. 1891. (In Transactions of the American Society of Mechanical Engineers, v. 12, p. 955-974.)
- The same, abstract.* 1891. (In Journal of the Iron and Steel Institute, v. 40, p. 309-311.)
Gives results of tests and various uses of manganese steel.
- Howe, Henry M.* Manganese Steel. 1893. (In Journal of the Franklin Institute, v. 135, p. 114-128, 191-200.)
- Howe, Henry M.* Metallurgy of Steel. v. 1. 1895. Manganese steel is discussed, p. 48, 361-365.
- Howe, Henry M.* Note on Manganese-Steel. 1893. (In Transactions of the American Institute of Mining Engineers, v. 21, p. 625-631.)
- Howe, Henry M.* Role of Manganese. 1917. (In Proceedings of the American Society for Testing Materials, v. 17, pt. 2, p. 508.)
- The same.* 1917. (In Engineering and Mining Journal, v. 104, p. 467-468.)
- The same, abstract.* 1917. (In Iron Age, v. 100, pt. 1, p. 239.)
- The same, condensed.* 1917. (In Iron Trade Review, v. 60, p. 1401-1402.)
Discusses mechanical properties of manganese steel.
- Improved Manganese Steel. 1915. (In Machinery, v. 21, p. 450.)
Improved steel possessing the characteristic hardness of the regular manganese steel, but which contains less manganese.
- Jacobs, F. B.* Grinding Manganese Steel Castings. 1921. (In Foundry, v. 49, p. 767-770.)
Discusses the method and reasons for grinding.
- Johnson, F. E.* Manganese Steel. 1910. (In Journal of the Association of Engineering Societies, v. 45, p. 175-183.)
- The same, abstract.* 1911. (In Engineering Review, v. 24, p. 173.)
- The same, abstract.* 1911. (In Foundry, v. 37, p. 243-244.)
Paper read before the Utah Society of Engineers.
- Johnson, R. M.* Manganese Steel Grinding. 1920. (In Grits and Grinds, v. 11, No. 10, p. 2-8.)
- The same.* 1920. (In Foundry, v. 48, p. 659-661.)
- The same.* 1920. (In Iron Trade Review, v. 66, p. 999-1001.)
- Killing, Erich.* Beitrage zur Frage der Mangan-ausnutzung im basischen Martinofen. 1920. (In Stahl und Eisen, v. 40, pt. 2, p. 1545-1547.)
Discusses experiments on conditions necessary to secure the most effective use of the manganese additions.

Lake, E. F. Manganese Steel and Some of Its Uses. 1907. (In *American Machinist*, v. 30, pt. 1, p. 700-702.)

Discusses its advantages over carbon steel for rails, vaults, etc.

Law, E. F. Effect of Mass on Heat Treatment. 1919. (In *Proceedings of the Steel Treating Research Society*, v. 2, No. 2, p. 11-19, 31.)

Discusses mechanical properties of manganese steel as influenced by various heat treatments, p. 14.

Ledebur, A. Ueber Manganstahl. 1893. (In *Stahl und Eisen*, v. 13, p. 504-507.)

Levin, M., and Tammann, G. Ueber Mangan-Eisenlegierungen. 1905. (In *Zeitschrift fuer Anorganische Chemie*, v. 47, p. 136-144.)

The same, abstract translation. 1908. (In *Revue de métallurgie*, v. 5, pt. 1, mémoires, p. 537-539.)

Gives results of experiments of the heating and cooling curves of manganese-iron alloys.

Machine Shop without Cutting Tools. 1909. (In *American Machinist*, v. 32, pt. 2, p. 893-897.)

Deals with appliances used in building burglar proof safes of manganese steel which can only be machined by grinding.

McKee, Walter S. Manganese-Steel Castings in the Mining Industry. 1916. (In *Transactions of the American Institute of Mining Engineers*, v. 53, p. 437-450.)

The same, condensed. 1915. (In *Iron Age*, v. 96, pt. 2, p. 1362-1365.)

The same, without discussion. 1915. (In *Iron Trade Review*, v. 57, p. 1077-1081.)

Considers their characteristics, some of their uses, foundry practice and heat treatment.

McKee, Walter S., and Blake, J. M. Manganese Steel Castings in the Mining Industry. 1921. (In *Transactions of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia*, v. 24, p. 188-195.)

Gives the chemical and physical properties, heat treatment and uses.

McKee, Walter S. The Manufacture of Manganese Steel Castings. 1917. (In *Transactions of the American Foundrymen's Association*, v. 25, p. 403-426.)

The same. 1917. (In *Foundry*, v. 45, p. 141-146.)

The same. 1917. (In *Iron Trade Review*, v. 60, p. 413-418.)

Discusses the difficulties encountered in making alloy castings, and application of manganese steel to various kinds of work.

Making Manganese Steel by the Open-Hearth Process. 1919. (In *Iron Trade Review*, v. 65, p. 1701-1705.)

Making Manganese Steel Castings Machineable. 1912. (In *Foundry*, v. 40, p. 271.)

Method of softening the castings by heat treatment.

Manganeisenhaltige Legierungen und Ihre Herstellung und Verwendung. 1912. (In *Elektrochemische Zeitschrift*, v. 19, p. 131-133.)

Includes use of ferromanganese, etc., in manganese steel.

Manganese Steel for Burglar-Proof Safes. 1899. (In *Journal of the Franklin Institute*, v. 147, p. 491.)

Manganese Steel Products. 1909. (In *Iron Age*, v. 84, pt. 1, p. 984-987.)

Deals with the progress of the Potter process of rolling manganese steel.

Manganese Steel Track-Work Specifications. 1915. (In *Electric Railway Journal*, v. 45, p. 1118.)

Manufacture of Manganese Steel Castings. 1913. (In *Iron Trade Review*, v. 52, p. 1404-1411.)

Discusses the practice of the Edgar Allen American Steel Co.

Mars, G. Die Spezialstaehle; Ihre Geschichte, Eigenschaften, Behandlungen und Herstellung. Ed. 2, rev. 1922.

Contains bibliographical foot-notes.

Treats of manganese steel, p. 287-331.

Mesnager, A. Essais d'aciers spéciaux sur les chemins de fer et tramways. 1921. (In *Le Genie civil*, v. 79, p. 155.)

Discusses advantages of Hadfield steel (12 per cent manganese) for railway parts exposed to heavy wear.

Metcalf, William. Steel; a Manual for Steel Users. 1900. Wiley.

Treats of the properties of steel, effect of impurities, theory and methods of hardening, tempering, annealing, etc. Manganese steel, p. 33-35.

Mukai, Tetsukichi. Studien ueber chemisch-analytische und mikroskopische Untersuchungen des Manganstahls. Friedberg. 1892.

Not in Carnegie Library of Pittsburgh.

New Track Appliances. 1913. (In *Railway and Engineering Review*, v. 53, p. 955-957.)

Committee report to the Roadmasters' and Maintenance of Way Association on manganese steel appliances.

Onnes, Kamerlingh, and others. On the Influence of Low Temperatures on the Magnetic Properties of Alloys of Iron with Nickel and Manganese. 1921. (In *Proceedings of the Royal Society of London, Series A*, v. 99, p. 174-196.)

Osmond, F. Sur la cristallographie du fer. 1900. (In *Annales des mines*, v. 196, mémoires, p. 110-165.)

Discusses the structure of manganese steel, p. 138-139.

Pennington, H. R. Welding Frogs and Crossings with Manganese Steel. 1922. (In *Railway Review*, v. 70, p. 153-157.)

The same. 1922. (In *Engineering and Contracting*, v. 57, p. 152-154.)

Discusses the qualities of manganese steel and methods of using it in welding operations.

Portevin, A., and Le Chatelier, Henry. Sur les aciers au manganèse. (In *Comptes rendus hebdomadaires des séances de l'Académie des Sciences*, v. 165, p. 62-65.)

Gives results of the effect of very slow cooling on manganese steels of different percentages of manganese.

Potter, W. S. Manganese Steel. 1909. (In *Journal of the Western Society of Engineers*, v. 14, p. 212-240.)

The same, abstract. 1909. (In *Iron Trade Review*, v. 44, p. 584-587.)

Deals with the physical properties and heat treatment, and gives results of a series of tests to determine the coefficient of friction between chill cast and steel-tired wheels, and Bessemer and manganese steel rails.

Potter, W. S. Manganese Steel, with Especial Reference to the Relation of Physical Properties to Microstructure and Critical Ranges. 1914. (In *Transactions of the American Institute of Mining Engineers*, v. 50, p. 437-475.)

Recent Solid Manganese Steel Crossings. 1915. (In *Electric Railway Journal*, v. 45, p. 711-712.)

New method of manufacture of manganese steel castings for special track work.

Revillon, L. Les aciers spéciaux. (1907.) Masson. (Encyclopédie scientifique des aide-mémoire.)

Concise review of their physical and chemical properties, methods of working and uses.

Treats of manganese steel, p. 65-82, also of nickel-manganese, manganese-silicon and manganese chromium steels.

Rhodes, J. B. A Development of a High-Grade Alloy Steel at Low Cost. 1915. (In Journal of the American Society of Naval Engineers, v. 27, p. 911-915.)

The same. 1915. (In Iron Age, v. 96, p. 1553-1554.)

Discusses high grade castings and forgings of a manganese-copper-nickel steel showing superior static properties and developed at a low cost.

Roberts, H. W. Relative Life of Manganese and Open-Hearth Rail on Curves. 1918. (In Electric Railway Journal, v. 52, p. 697.)

The same, abstract. 1918. (In Engineering and Contracting, v. 50, p. 479.)

Gives results of tests showing manganese rails to wear about seven times as long as open-hearth.

Rolled Manganese Steel Rail. 1908. (In Railroad Age Gazette, v. 45, p. 1536-1538.)

Rouelle, Jean Baptiste Celestin. L'aciers; élaboration et travail. 1922. (Collection Armand Colin. Section de chimie.)

Outlines methods of manufacturing steel and special steels, and deals with testing, heat treatment, shaping and working. Treats of manganese steel, p. 87-89.

Rudhardt, Paul. Les métaux utilisés la technique moderne et leur traitement rationnel. Ed. 2. 1920.

Treats very briefly of manganese steel, p. 153.

Ruemelin, G., and Fick, K. Beitrage zur Kenntnis des Systems Eisen-mangan. 1915. (In Ferrum, v. 12, p. 41-44.)

Discusses the physical and chemical properties, and contains numerous foot-note references.

Sauveur, Albert. Manganese Steel and the Allotropic Theory. 1914. (In Transactions of the American Institute of Mining Engineers, v. 50, p. 501-514.)

Sauveur, Albert. Metallography and Heat Treatment of Iron and Steel. Ed. 2. 1916. Sauveur.

Treats of manganese steel, p. 343-346.

Schneider et Cie. L'acier au manganèse. 1909. (In Revue de métallurgie, v. 6, mémoires, p. 551-561.)

Treats of the properties and applications.

Schuler, E. J. Manganese Special Work Welding. 1924. (In Engineering and Contracting (Railways), v. 61, p. 419-420.)

Selleck, Theodore G. Practical Talks on Case-Hardening. 1919. (In Journal of the American Steel Treating Society, v. 1, p. 325-335.)

Gives table of carbonizing efficiency of various steels, including manganese, p. 335.

Shaner, E. L. Making Manganese Steel by the Open-Hearth Process. 1920. (In Foundry, v. 48, p. 63-66.)

Discusses how steel containing 12 per cent manganese is made by open hearth process.

Sirovich, G. Deoxidation of Steel by Silico-Manganese. 1919. (In Journal of the Iron and Steel Institute, v. 99, p. 662.)

Brief abstract from Metallurgia Italiana, 1918, v. 10, p. 353-357.

Spring, La Verne Ward. Non-technical Chats on Iron and Steel and Their Application to Modern Industry. 1917. Stokes.

Treats of manganese steel, p. 235-236.

Springer, J. F. Manganese Steel. 1910. (In Casier's Magazine, v. 39, p. 99-116.)

Deals with properties and tests of manganese steels.

Stadler, A. Einfluss des Mangans auf die mechanischen und strukturellen Eigenschaften niedriggekohten Flusseisens gewöhnlicher Handelsqualitaet. 1913. (In Zeitschrift fuer Anorganische Chemie, v. 81, p. 61-69.)

Stone, S. R. Manganese Steel for Machinery Parts. 1913. (In Iron Age, v. 91, pt. 1, p. 140-142.)

Discusses the variety of service in which such castings have been used to advantage.

Stoughton, Bradley. The Metallurgy of Iron and Steel. Ed. 3. McGraw. 1923.

Discusses manganese steel, p. 435-437.

Strauss, Jerome. Characteristics of Some Manganese Steels. 1923. (In Transactions of the American Society for Steel Treating, v. 4, p. 665-708.)

Gives a brief history of iron-manganese alloys, and discusses the mechanical, electrical and magnetic properties, and shows the relation of microstructure to mechanical properties in a series of steels.

Strauss, Jerome. Properties of Manganese Steels. 1920. (In Proceedings of the Steel Treating Research Society, v. 2, No. 11, p. 14-19, 47.)

Short review of the physical and mechanical properties as influenced by various heat treatments.

Strong, J. B. Manganese Construction in Track Work. 1920. (In Official Proceedings of the St. Louis Railway Club, v. 25, No. 5, p. 47-55.)

The same, abstract. 1920. (In Engineering and Contracting, v. 54, p. 499.)

The same, abstract. 1920. (In Railway Review, v. 69, p. 928.)

Strong, J. B. Rolled Manganese Steel Rails. 1909. (In Railway and Engineering Review, v. 49, p. 214-215.)

Tarugi, N. Neues Verfahren zur Verwertung stark Siliciumhaltiger Eisen- und Mangan-Mineralien. 1913. (In Chemiker-Zeitung, v. 37, p. 511-512.)

Way Engineer. Welding Manganese Steel. 1916. (In Electric Railway Journal, v. 48, p. 27-28.)

Brief discussion of P. A. E. Armstrong's and W. S. Potter's articles.

Welding Manganese Steel. 1923. (In Journal of the American Welding Society, v. 2, No. 6, p. 39-56.)

Questions asked the bureau of information of the American Welding Society on electric welding of rails, and giving the opinion of competent engineers on the subject.

Wickhorst, M. H. Tests of Manganese Steel Rails. 1918. (In American Railway Engineering Association, v. 19, p. 472-491.)

The same, abstract. 1918. (In Iron Age, v. 101, pt. 1, p. 560-561.)

The same, abstract. 1918. (In Railway Age, v. 64, p. 162.)

Gives a report of the behavior of manganese steel rails under service conditions.

Zerhansen, F. R. How Manganese Steel Castings are Made. 1914. (In Foundry, v. 42, p. 132.)

The same, abstract. 1914. (In Machinery, v. 20, p. 831.)

Details of molding, melting and pattern making.

CURRENT REVIEW

Lubrication of the Automatic Stoker

By A. F. BREWER*

Fuel conservation is one of the paramount features of modern boiler plant operation. It is, in fact, the keynote of efficient combustion, for boiler efficiency is directly dependent upon the amount of fuel burned in the evaporation of water into steam. Solid fuels are in general, more susceptible to wasteful handling and firing than either liquid or gaseous fuels; therefore, automatic means to improve this condition have been developed in the shape of the mechanical stoker.

The mechanism of the modern stoker is relatively simple in design, the driving unit being the essential part requiring lubrication. Individual manufacturers, however, employ various adaptations or types of drives according to the operating requirements of their stoker.

Stoker fuel is fed in at either the sides or front end of the furnace through a hopper or magazine, being distributed along the top of an inclined set of grates. In the front feed stoker the grates slope towards the rear of the furnace, being set in one uniform plane. In the side feed furnace there are two sets of grates, each set sloping towards the center, making an angle or V at their lowest point.

Certain of the grates in an overfeed stoker installation move backward and forward with respect to each other, being actuated by kicker or rocking bars. This motion carries the fuel down the grates to the rear or center. All this time combustion is taking place, coking and the burning of volatile gases occurring while the coal is on the upper parts of the grate. When the fuel has been carried to the clinker crusher or dumping device at the bottom of the grate or grates, it should have been completely burned and should then be ready

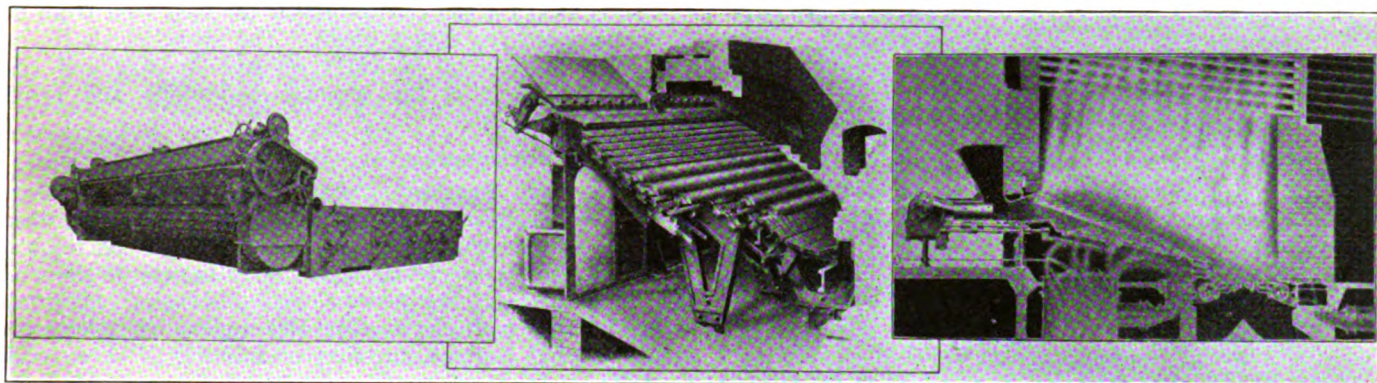


FIG. 1.—View of a chain grate stoker showing grates in course of passage over the front sprocket, the regulating and control mechanism, etc. An advantage of this type of stoker is that the entire device can be readily removed from the furnace for repair or inspection without disturbing the boiler or setting. FIG. 2.—Sectional view, in perspective, of a mechanical stoker of the overfeed type. Details of grate construction are clearly shown. FIG. 3.—Longitudinal section through a typical underfeed type of stoker. The actual relation of the fuel and fuel bed to the operating mechanisms of the stoker is clearly shown.

ers. In studying stoker lubrication we must as a result, look into the several designs or basic types in use today, inasmuch as lubrication will be materially contingent thereupon.

Types of Stokers.

There are three distinct types of automatic stokers on the market, viz.:

- (a) The overfeed
- (b) The underfeed and
- (c) The chain grate or traveling stoker.

To a certain extent their names imply the manner in which coal is fed to the furnace. In the Overfeed

for discharge as ash. Overfeed stokers are adaptable to the firing of coking varieties of coal due to the motion of their grates which keeps the fuel bed porous and broken up, thus preventing caking or the formation of clinkers.

Underfeed stokers involve the introduction of fresh coal beneath the fuel bed by means of steam or electric driven rams or plungers. The coal is usually delivered through a gravity feed hopper to the several retorts in which these rams or plungers operate. Essentially these retorts are individual primary combustion chambers, the sides being either stationary or subject to reciprocating motion. These sides also serve to carry the tuyeres or air grates, the latter consisting usually of a number of superimposed perforated plates.

As fresh coal is fed into the retorts it is gradually forced underneath the fuel bed by the action of either the plunger alone or a number of automatic auxiliary

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distributing pushers or plungers. This movement of the base of the fuel bed, together with the continued air blast which is delivered through the tuyeres, insures against caking or any tendency towards dirty fires. The volatile gases are driven off as the fresh coal becomes hotter and hotter through its proximity to the fuel bed above, being burned as they pass through this heated area; the green coal meanwhile becomes gradually coked and ultimately burned completely.

The chain grate or traveling stoker involves an endless chain which passes over suitable sprockets at the front and rear of the furnace, the meshed link or bars of this chain serving as the grate or fuel bed. This chain is in motion continuously, passing round and round through the furnace, taking fresh fuel at the front end of the furnace and discharging the residual ash at the rear, as the chain turns over the sprockets. The necessary sprockets are fastened to suitable shafts which are part of the base frame of the stoker. Either the front or rear sprocket can be used as the driving element by suitable connection to a worm reduction gear mechanism, which in turn may be either driven by a steam engine or electric motor.

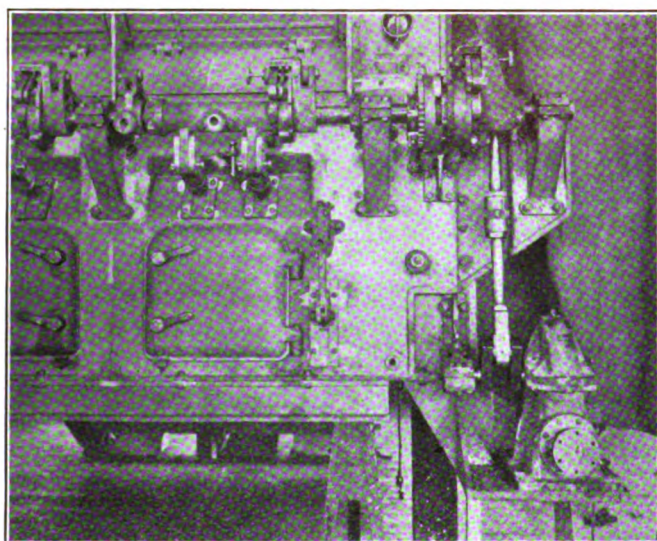


FIG. 4.—Front view of a mechanical stoker showing worm reduction gearing enclosed in an oil-tight casing, the mechanical timer with four speed reduction, and the kicker bar operating mechanism with driving rod.

Coal is fed by gravity to the chain grate stoker in much the same manner as to the other types mentioned above; usually a suitable hopper is installed for this purpose at the front end of the furnace. The necessary air for combustion is delivered through the chain grate via either one or more distributing compartments below the top grate.

Stoker Drives.

In order to manipulate the grates of the overfeed stoker, operate the plungers and rams of the underfeed machine, run the chain grate at the desired speed, and turn the clinker grinder, it is essential to use some form of reduction geared power unit. This is commonly either a small vertical reciprocating steam engine, a turbine or an electric motor. The several types of stokers on the market vary considerably in their methods of handling fuels just as they vary in regard to their driving mechanisms.

In the overfeed stoker the feature of operation is the rocking or reciprocating motion to which the grates are subjected. This is brought about by means of a kicker bar or rocker which receives its reciprocating motion from the driving unit through a crank, eccentric connection, or a series of toggle levers.

The underfeed stoker in general depends upon the reciprocating action of the plunger in the charging of fresh fuel and the pressure of the air blast, for the agitation of the fuel bed. Therefore, the essential operating mechanisms involved are the plunger and the coal feeding devices. The plungers and distributing rams are usually connected to the driving unit through a suitable crank shaft of heavy construction. The driving unit can also be further connected through crank, link or rod mechanisms to operate a clinker grinder if necessary, and also the reciprocating overfeed grates and retort side bars in some types of stokers. As a result a regular sequence of operation is maintained in all the necessary moving parts just as long as the driving unit is running and the proper connections are maintained.

The principle operating part in the chain grate stoker is the driving mechanism. As has already been stated this may be attached to either the front or rear sprocket shaft through suitable reduction gearing. Additional mitre gears in connection with adjustable ratchet mechanisms are also used on some front feed stoker drives for the purpose of regulating the coal feeding device. In other types a hand-wheel operated worm and gear device is used for the controlling of the coal feed from the hopper onto the stoker chain. The sprocket shafts are carried in pedestal bearings of suitable size and construction to meet the wearing conditions and enable proper lubrication.

Stoker Lubrication.

We have therefore certain definite details in every type of stoker which will require lubrication, i. e., there are the worms and gears, the miscellaneous bearings of the accessory connections which serve to operate the movable grates, etc., the pedestal and other more important bearings of both chain grate and underfeed stokers and the driving engines, turbines or motors. As a result, stoker lubrication can be discussed from three broad viewpoints, viz.: as applying to reduction gears, bearings and steam cylinders.

While many of the moving parts of any type of automatic stoker are exposed to a certain amount of heat, such connections as require lubrication are generally subject to far lower temperatures, although these latter may often be sufficiently high to render lubrication a serious problem. Bearings of movable grate connections as a rule will be chiefly affected in this respect. Other operating parts being outside the furnace receive only the heat of radiation from the boiler.

Reduction Gears.

Worm and spur gears are the main parts which must be lubricated. According to the make of stoker, the worms may be located either above or below the main driving gears. As a result, their lubrication requires consideration from two angles. Stokers normally run at low speeds due to the gradual rate at which the coal must be fed. As a result large speed reductions are used especially where the prime mover is a turbine or an electric motor. The selection of the lubricant for a stoker worm drive should be based primarily upon the type of gear casing installed. In other words an oil tight casing will enable the employment of bath lubrication and the use of a lubricant of just sufficient viscosity to preclude wear-

ing of the teeth. Where but a safety gear shield or an open or leaky case is involved, naturally we must turn to the heavier, more plastic grades of lubricants.

Essentially a worm gear installation will require a comparatively heavy, adhesive lubricant which will not wipe off the teeth when subjected to the combined sliding and rolling action of the teeth. Furthermore, in many installations the same lubricant must not only serve to lubricate the gears but also the worm shaft thrust bearings. Inasmuch as the lubricating requirements will differ considerably, in such cases it will be necessary to compromise and use a lubricant as suitable to both as possible. Usually a straight mineral product of about the consistency of steam cylinder oil will meet these conditions.

The location of the worm with respect to the gear is important not only from the viewpoint of selection of the grade of lubricant, but also as to the manner of lubrication. When the worm is located below the wear it should be submerged to approximately the center line of the worm shaft. This will insure the transference of sufficient lubricant to the gear teeth as they mesh with the worm. This condition does not occur to the same extent, however, when the worm is above the gear, due to the lower surface area of the gear teeth, and the fact that the lubricant will tend to travel along the worm shaft and drip down outside the trough. Also, especially when the stoker is first started up will there be a possibility of an insufficient film of lubricant being carried by the gear teeth to the worm. To forestall these conditions, it is advisable to run the gears submerged to the full depth of their lower teeth in a bath of lubricant, and use a highly adhesive, though relatively fluid, product which will stick tenaciously to the worm teeth and not drip off even where radiated heat may be relatively high.

When worm drives are not enclosed in an oil-tight casing bath lubrication is usually precluded, and it becomes necessary to apply the lubricant by hand, in heated condition, by means of a brush. In such instances the lubricant must be of considerably higher viscosity than specified above since it must maintain a suitable film on the teeth for the usual considerable period of time which elapses between applications. Low viscosity oils or non-adhesive greases will drip off when thinned down under the higher temperatures encountered. For such gears it is therefore advisable to use a straight mineral gear lubricant of approximately 1000 sec. viscosity Saybolt of 210 deg. F. Dirt and dust must also be considered when lubricating worm reduction gears of this nature. Therefore, frequent attention should be given to cleaning the entire mechanism, otherwise excessive wear may occur due to the presence of abrasive material in the lubricating film on the teeth.

Bearings.

Bearings in a stoker installation are internal and external in location. Internal bearings usually get little or no lubrication; in fact they are generally built with relatively high clearances, to operate without oil. The amount of motion to which they are subject is relatively slight, as is also the comparative rubbing speed. Therefore, heat conditions are really the only detriments involved.

External bearings, however, should receive careful attention. Frequently they are designed for grease lubrication, being equipped with suitable grease cups. These latter are advantageous in that they are usually dustproof and insure a supply of clean lubricant to the bearing surfaces. Grease also tends to work out toward

the end of the bearing, thus preventing the entry of dust along the shaft. For such service a medium bodied compression cup grease free from thickeners or non-lubricating adulterants will function best. It is perfectly possible, however, to lubricate stoker bearings with oil and this is often done where it is desirable to use one product for the external bearings of both the prime mover and the stoker. In such cases a medium viscosity engine oil of about 300 sec. viscosity Saybolt at 100 deg. F. will be suitable.

Prime Movers.

In general the above will include steam engines, steam turbines, electric motors, silent chain drives, or in certain cases, line shafting and belts. The lubrication of such equipment has been extensively dealt with in recent issues of LUBRICATION. *Therefore reference is made to those articles.

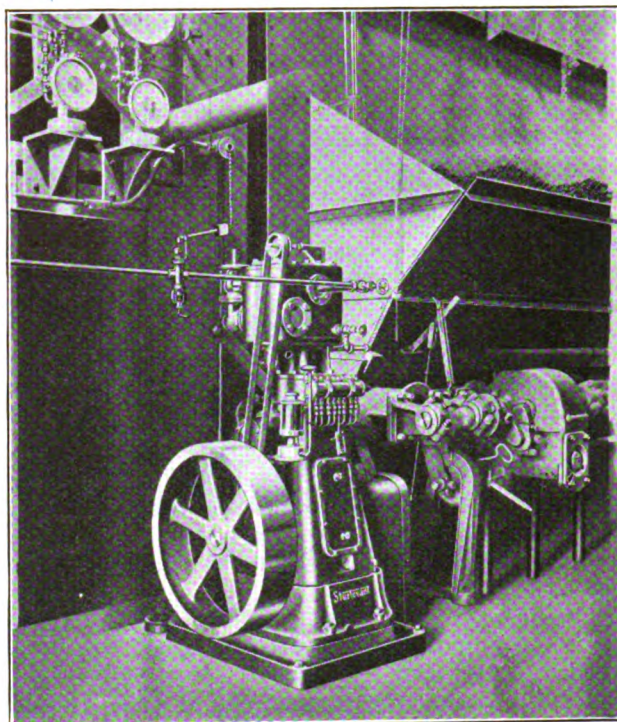


FIG. 5.—A vertical type of stoker driving engine showing method of connection to the stoker proper, and the means installed for lubrication.

Certain types of stokers may be equipped with vertical, reciprocating, enclosed crankcase steam engines, usually of the single acting type. In this event a few words of detail regarding their lubrication will be of interest.

In the lubrication of these engines the design not only does not aim to prevent the entry of water but actually makes use of this latter as a carrier for the oil. During the process of lubrication the oil in the crankcase not only serves the bearing but also the cylinder walls to a partial extent, co-operating in this latter with the oil which is fed with the steam. To obtain effective lubrication the crankcase must be filled with water (preferably condensate) to the level of the overflow pipe. On top of this body of water is carried a $\frac{1}{8}$ to $\frac{1}{2}$ -in. film or layer of specially refined lubricating oil. As the crank disc dips into this the requisite amount of lubricant is thrown to the cylinder walls, and internal bearings. The purpose of using a mixture of oil and water for lubrication

*November, 1923; April, 1924.

is to enable the attainment of a more effective distribution of the oil than were the latter used alone.

Thereby, too, it is possible to bring about lubrication of both cylinders and bearings by means of one oil, and that a heavier product than would normally be used for other splash feed systems. Usually this oil must have a viscosity in the neighborhood of 100 sec. Saybolt at 210 deg. F. Furthermore, it must separate readily from water, yet it must have sufficient adhesive ability to render it capable of clinging to the cylinder walls in the presence of water. Emulsification to a slight extent does no harm, but there is always possibility of repeated churning causing thick emulsions or "livering," especially if too much oil is used or if it has not been sufficiently carefully refined and prepared. Emulsions will naturally tend to render the lubricating system inoperative.

Main bearings of such engines are usually lubricated by sight feed oil cups or compression grease cups. The steam in turn is lubricated as necessary through hydrostatic or force feed oilers using oftentimes the same grade of oil as in the crankcase.

Conclusion.

While we have touched but briefly upon this most important feature of steam power plant operation—the lubrication of the automatic stoker—enough stress has been laid upon the construction, design and the operating features involved to indicate the importance of proper and sufficient lubrication. Upon the operation of the stoker will depend our rate of steam production. Therefore, even though our stoker may be apparently rugged and seemingly immune from lubrication difficulties, it will pay to give it careful attention and remember that it is quite as deserving of the best grades of lubricants as the other operating units in the plant.

Excerpts from the Steel Trade Weeklies

The Federal Trade Commission sums up results of the abolishment of Pittsburgh plus, viewing the tendency toward delivered prices as retarding adjustment.

A cablegram from London states that as a result of the defeat of the labor party in Great Britain the British iron and steel markets are more buoyant.

The twenty-eighth convention of the American Foundrymen's Association at Milwaukee breaks all records in point of attendance, with 5,031 registered.

Confidence is returning in the iron and steel markets, and buying is much heavier, stimulated to some extent by the optimism expressed at the meeting of the Iron and Steel Institute in New York, especially in the address of E. M. Gary.

November 6.

October pig iron production was 2,461,144 tons, an increase of 407,827 tons over September. On an average daily basis the gain was 16 per cent over September.

An article by Leonard P. Ayres, vice president, Cleveland Trust Company, illustrated with charts, shows the relationship between pig iron production and prices consecutively since 1898. Prices lag at start of recovery of production.

The American Welding Society in annual convention at Cleveland urge the fabrication of steel structures by means of welding.

Total ingot production in October was at the annual rate of 35,840,000 tons, compared with 33,670,000 tons in September. The October output was 3,111,452 tons, the highest point since April.

Traffic managers of leading iron and steel producers meet in Pittsburgh and appoint a committee to formulate a program for rate revisions.

Technical Articles.

Description of an Oklahoma foundry producing special electric steel castings as required for larger demand in the southwestern oil fields.

The Otis Steel Company of Cleveland joins the ranks of strip producers. Completion of new open-hearth capacity affords it control over materials. Blooming mill hydraulic system is unique. No cooling bed in hot strip mill.

A technical description of a tin plate plant built in India by American and British engineers.

A Milwaukee manufacturer of steel castings adopts electric furnace for annealing and heat treating. Variable input arrangement conserves power. Transfer table and storage track facilitate handling of cars.

A description of a new fire clay mill near Joliet, Illinois.

—Iron Trade Review.

Current Articles

Tooling for Small Quantity Work

Jobs not calling for bulk production put through on semi-production basis—savings accomplished by grouping operations.

An American Tin Plate Plant in India

New York engineers make many modifications to meet climatic conditions—marked success of early operations.

Iron Ore Available for United States

Reserves of the world which may be smelted in American furnaces—Our own reserves should last 250 years.

Nitrogen in Steel—Prevention or Cure?

Its removal facilitated by various additions—Low temperature production of iron in the blast furnace advocated as a preventive.

Making Large Size Hammer-Welded Pipe

Penstocks, tanks, stills, digestors and receivers—Methods of forming and welding—Finishing to size important.

Steels at Highest Working Temperatures

Changes in strength and other properties of carbon and alloy steels at 500 to 1200 deg.—Range of "reduced malleability" in hot working.

Steady Business Improvement Expected

Washington cheerful after the election—General congratulation on account of collapse of Gompers-La Follette radicalism.

Judge Gary Tells About Stinnes Interview

Was powerless to act unless steel manufacturers of all countries could work in harmony—Recent talk about an international meeting.

Horizontal Ring Induction Furnaces

Comparison with electric arc furnaces for metals—Attractive features of induction melting—Results from a 6-ton unit.

Eliminating Blue Prints in Machining

Jigs registered from a machined surface are used for tool setting—"Greased Air" Employed in deep-hole drilling.

—IRON AGE during November.



Southern Pacific locomotive equipped with firebox with one-piece crown, sides and combustion chamber.

One Piece Plate for Locomotive Fireboxes

ABOUT six years ago the Lukens Steel Company installed a 206-inch mill for rolling and handling wide plates such as are now used on many railroads in the construction of a one-piece plate which comprises the crown sheet, side sheets and combustion

chamber of a firebox. The Lukens Steel Company furnishing only the flat plate.

The advantages of the one-piece crown, sides and combustion chamber are many. It not only makes a nicer appearing box more easily handled in construction, but it also has an economic and safety value. In

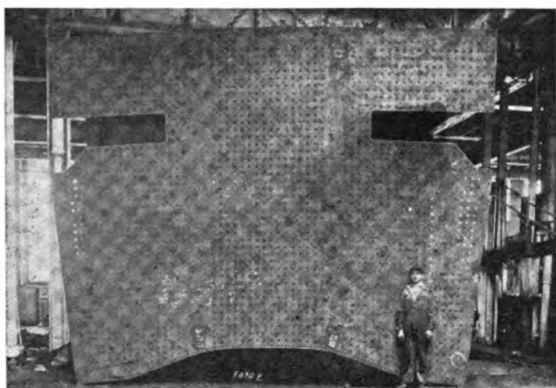


FIG. 1.—Plate cut to finished size.

tion chamber of a firebox. To bend or roll such a plate requires some art, for as you will note the sides have a straight slope with the crown curved to a radius and the combustion chamber makes a complete shell.

The plates used in this construction are generally of $\frac{3}{8}$ -in. gauge material and usually measure for the larger locomotives anywhere from 180 to 195 inches wide. The rectangular plate is cut out and drilled as shown in Fig. 1. The next procedure is to bend or form the plate as shown in Figs 2 and 3. Of course, the size and shape of these vary in accordance with the different locomotives for which they are required. The next step is to weld in the throat sheet and attach the mud ring, Fig. 4. The box is now ready for installation on the locomotive. All of the work as shown in the illustrations is done by the locomotive builder,

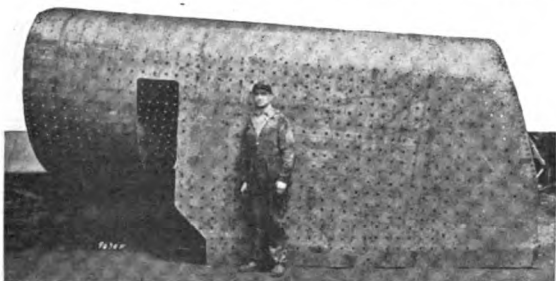


FIG. 2.—Plate formed for use.

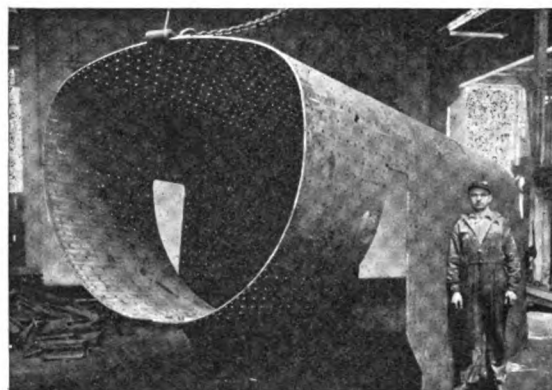


FIG. 3.—Firebox made of one piece plate.

the first place, the seams are eliminated; this not only means the reduction in cost of drilling, riveting, calking etc., but it avoids all the dangers of leaks which are prevalent at such joints. In addition, as the transmission of heat from fire to water is important, the



FIG. 4.—Firebox and combustion chamber.

construction of one-piece crown, sides and combustion chamber makes only one thickness of metal throughout the entire firebox and combustion chamber for the heat to pass through. It has to pass through three thicknesses where joints are used with inside and outside butt straps as was required in the old construc-

tion. Still further, in cooling when the engine is out of operation or the fire removed for any purpose, all of the cooling strains concentrate at the joints. The rest of the box naturally cools more rapidly than the joints on account of the extra metal concentrated at the joints, hence all the cooling stresses act on the hotter metal and practically all the strain is concentrated here. Everyone having experience with loco-

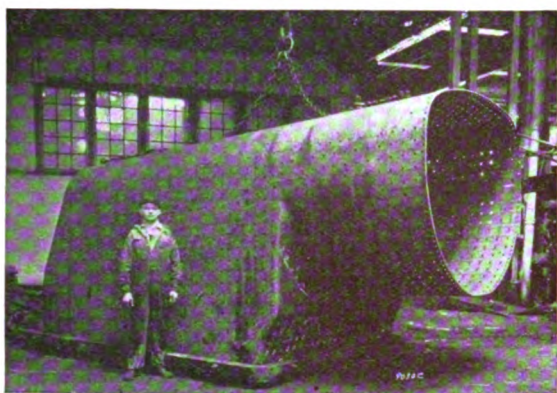


FIG. 5.—Firebox made from plate 241 by 195 inches.

motives of the old construction knows that it is at such joints that the cracks and failures invariably occur.

The new construction of one-piece crown, sides and combustion chamber has now been given a thorough trial, and locomotives of such construction have been in operation long enough to prove their great value in efficiency, economy and safety.

The mill for rolling the plates has two 30-ton working rolls, each of which are supported by 60-ton reinforcing rolls, making the mill very stiff and allowing for the rolling of a uniform plate of quality with a



FIGS. 6 and 7.—Locomotives equipped with one-piece fireboxes.

clean, smooth surface. The mill is driven by a 30,000-horsepower combined geared, reversible and condensing engine and has a capacity to handle 30-ton ingots.

It is interesting to note that the first boiler plates in America were turned out of the Lukens plant at Coatesville, Pa., this institution dating back to the year 1790 and formally established in 1810. We are indebted to the Lukens Steel Company for this information and illustrations.

—Railway Journal.

Centrifugal Applications

Utmost In Portability Assured This Transformer Oil Purifier — Mounted on a White truck with all auxiliaries it is used to dehydrate oil in the outlying districts served by a great utility company.

Erie County Electric Company Stops Turbine Trouble With Oil—Trace difficulty to lubricating oil, remedy it by filling system with another brand, and cure it by installing a purifier after exhaustive tests.

Located Near Coal and Water, This Plant Has Plenty of Pure Oil—Saxton plant of Penn Central Light and Power Company, located at the mouth of a coal mine, keeps turbine and transformer oil clean.

British Station Saves Cost of Two Purifiers in Seven Months — City of Sheffield (England), Corporation electricity department uses two stationary type De-Lavals to dehydrate transformer oil at central plant.

Purifier Protects the First Unit Installed at Waukegan Station — Newest plant of the Public Service Company of Northern Illinois is designed ultimately to be one of the world's largest generating stations.

Maximum Oil Temperature Drops 20 Deg. After a Purifier Is Installed — Dependable lubrication also helps Arizona Power Company to successfully carry a load which jumps from 1,000 to 7,400 kwh. in the course of 30 minutes.

Largest Power System In Hard Coal Field Works With Clean Oil — Transformer oil purifier cleans and dehydrates oil used in generating and distributing 31,000 kva. needed to meet power needs of Glen Alden Coal Company.

Says Transformer Oil Purifier Removes Sulphuric Acid from Oil—City Lighting Department of Seattle feeds 10 per cent of water through its purifier with the oil and finds that acidity is materially reduced.

Pneumatic-Tired Trailer Adds to Portability of This Oil Purifier — Central Hudson Gas and Electric Company develops compact transformer oil maintenance outfit with a machine mounted on a trailer built of Ford parts.

—DeLaval Centrifugal Review.

November Iron and Steel Engineer contains the following interesting articles:

Interchange of Power in the Southwestern States, by T. M. Oliver. An illustrated discussion of a new phase of power development, given by the Electrical Engineer of the Alabama Power Company before the Birmingham Section of the society.

Electric Mining Equipment, Its Selection, Care and Operation, by A. F. Elliot, Electrical Superintendent of Sloss Sheffield Steel & Iron Company. Given before the Birmingham Section.

Developments in Electric Maintenance Shop Practice. A general discussion by leading member electrical superintendents and engineers.

Spot Welding, by G. A. Hughes, Electrical Engineer, Truscon Steel Company, Youngstown, Ohio. An eight page technical paper reviewing the progress made by the use of the spot welder.

The POWER PLANT

Planning Modern Stoker Installations

Resume and Analysis of the Important Combustion Problem by a
Specialist of Broad Experience

By JOSEPH G. WORKER

THERE have been many changes in the past year in the manner of boiler and stoker combinations; more narrow and higher tubed boilers are being used, and on horizontal tube boilers the front header is being set 18 feet from the floor line. A few years ago, draft was everlasting trouble maker with stokers, but today, adequate stacks are being installed to give sufficient draft to burn the maximum amount of coal the equipment is designed for.

*Assistant to the President, American Engineering Corporation, Philadelphia, Pa.

Of course, the modern boiler and stoker setting is costing more money than it did a few years ago, but this expenditure is being justified.

The coals used in most of the central stations in the East are semi-bituminous and bituminous coming from Virginia, West Virginia, Pennsylvania, etc. Of all the several types of stokers to select from a few years ago—the field has sifted until now, the multiple retort stoker, Fig. 1, is almost universally used. The engineer of today has no difficulty in selecting the

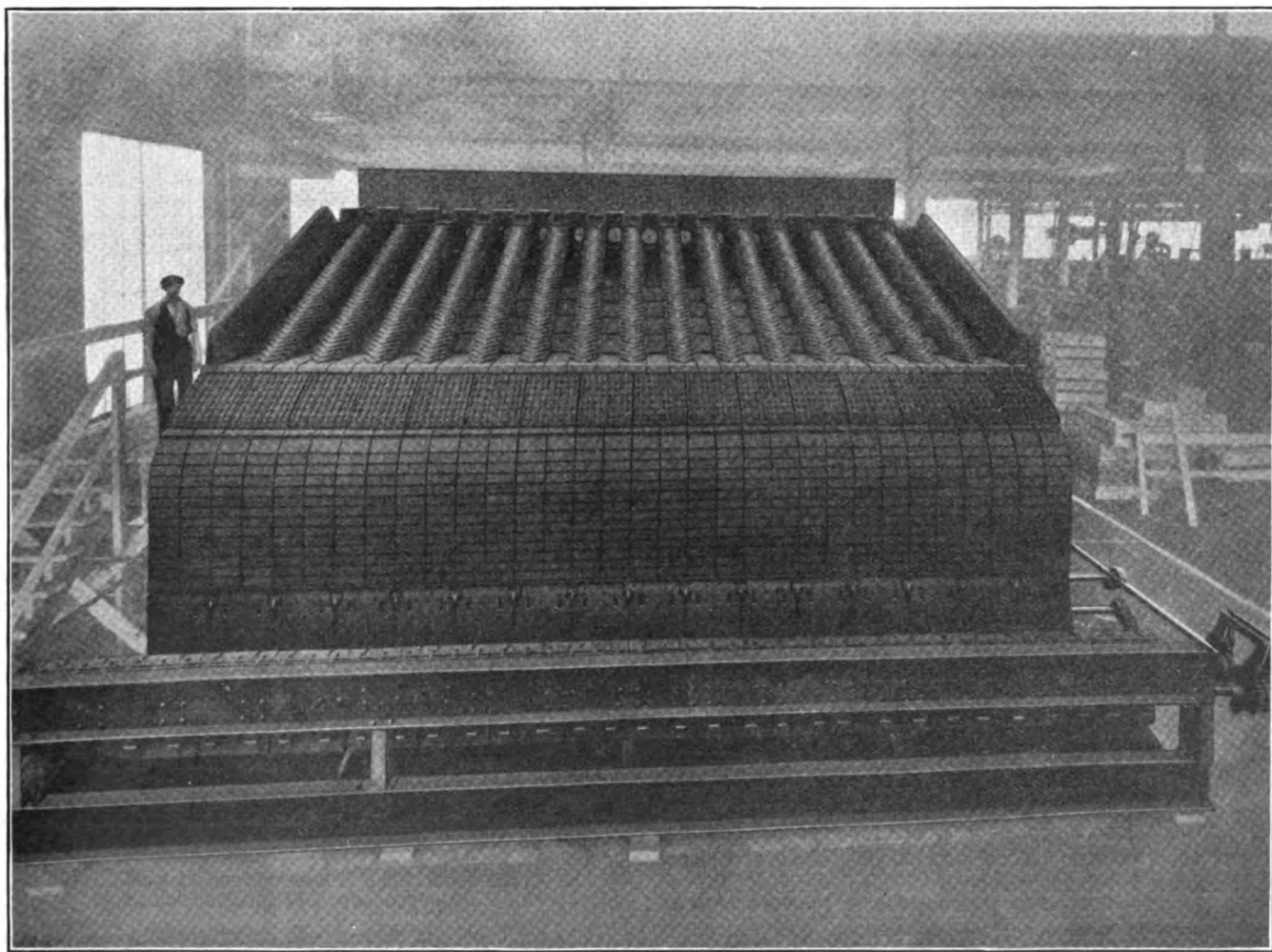


FIG. 1.—One of the longest and largest of the modern multiple retort underfeed stokers.

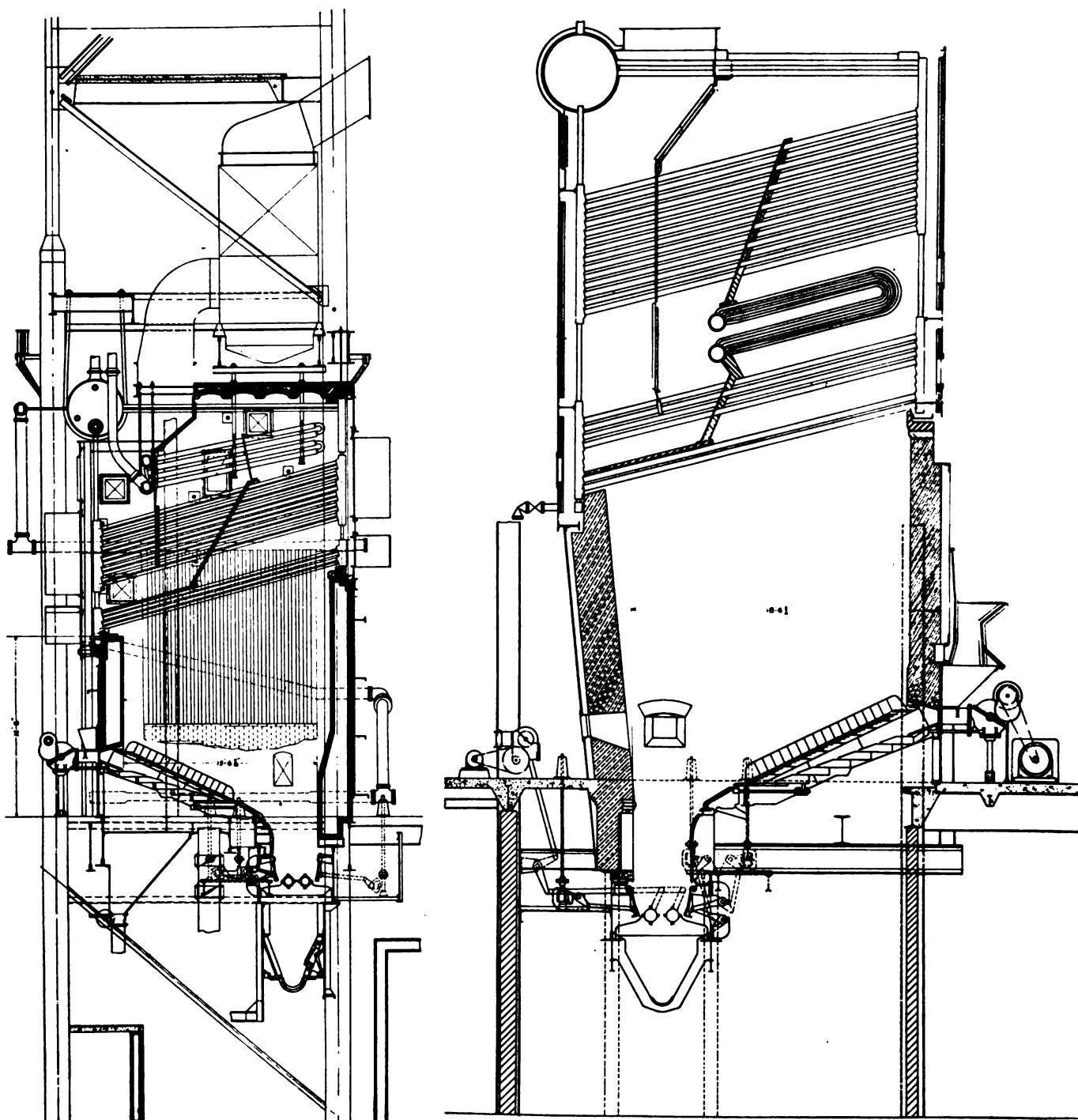


FIG. 2.—(Left)—92 per cent efficiency and over 600 per cent of boiler rating obtained with this underfeed stoker setting at the Hell Gate station of the United Electric Light and Power Company. Engineers—Thomas E. Murray, Inc. FIG. 3.—(Right)—One of the most modern underfeed stoker settings now being installed at the Kearney Station of the Public Service Company. Engineers—Public Service Production Company.

type of stoker to be used for these coals in large stations, for modern stoker practice.

The underfeed stoker is used very generally as far west as Pittsburgh, Cincinnati, Toledo and Detroit, and one of the latest stations to use this stoker is the United Light & Power Company for their large new plant on the Mississippi River. The highest performance to be obtained on the underfeed stoker in the past is shown by the results at the Hell Gate Plant of the United Electric Light & Power Company of New York. Table 1 shows the heat balance.

In Illinois, where Illinois coals predominate, the forced draft chain grate is extensively used. This

stoker has been developed considerably in the past few years, and is nothing like the natural draft chain grate stoker. The natural draft chain grate stoker has almost passed out of existence as far as combination with large boilers are concerned. It is being replaced even in older plants by the forced draft chain grate stoker.

The performance to be expected from this type of stoker is indicated by the results of tests at the Calumet Station of the Commonwealth Edison Company of Chicago, which showed 75 per cent efficiency without economizers.

TABLE 1. — HEAT BALANCES

	Connors Creek (Detroit)	Lakeside (Milwaukee)	Hell Gate (New York)
Total heat absorbed, boilers, superheater and economizer ...	...	89.1%	92.7%
Heat absorbed by boilers and super- heater	76.0%	85.3	84.6
Heat absorbed by economizer	...	3.8	8.1
Heat carried away by dry gases	14.2	3.2	3.2
Loss — Combustible in ash or flue dust	3.6	0.5	0.4
Loss due to incom- plete combustion...	0.2	...	0.1
Heat carried away by steam in products of combustion	5.0	4.9	3.4
Radiation and unac- counted for losses	1.0	2.3	0.2
Total	100.0	100.0	100.0
Flue gas temperatures leaving boiler	604°F.	430°F.	485°F.
Per cent of rating— boiler and super- heater	137	147	181
CO ₂ leaving boiler...	11.8%	14.4%	13.04%
Btu. coal as fired....	12,072	11,483	14,010
Gain in boiler eff. if flue gases reduced to 430 deg.....	...	...	1.48%
Temperature air enter- ing	...	104°F.	65°F.
Theoretical gain with air at 140°.....	...	...	1.00%
Length of run.....	...	24.20 Hr.	28.0 Hr.
Flue gas temperature leaving economizer.	...	204°F.	193°F.

In planning new stoker installations, engineers are using new methods and are designing up to a high efficiency rather than down to an obsolete plant efficiency.

A few years ago, the results that could be obtained on stokers were measured by the character of the boiler that was placed over the stoker; that is, if the stoker was applied on the H.R.T. boiler, the efficiencies obtained were on one standard. When stokers were applied under water-tube boilers, it was then said that higher efficiencies could be obtained with stokers. The probabilities are that, as far as the stoker was concerned, and there was a method of measuring its efficiencies as an independent unit, it would be found that the stoker applied to H.R.T. boilers would be just as efficient as one applied to water-tube boilers; therefore, in planning modern installations, it should be first determined what efficiency is desired.

If 90 per cent efficiency is desired with the ordinary grade of coal, this is perfectly possible with the modern mechanical stokers, but the design must be such that the furnace and boiler construction handle the heat that is liberated from the stoker.

Engineers not long ago, in their study of a stoker and boiler, wanted to know what results were obtained on stokers when using this coal. This was the old way of going about designing a stoker installation. If this study showed that 75 per cent efficiency was obtained with this kind of coal on the particular stoker, then the new plant was designed along this line. The new method is to find out if 80 per cent or 90 per cent efficiency is possible, and if so, then go about designing the equipment that will give this efficiency and taking care that all elements are provided, that will eliminate wasted heat. That is, our old data book record of stokers is no longer of any use in designing the modern setting.

A few years ago, stokers were made 8 ft. to 10 ft. from the front wall to the bridge wall. This gave a very short travel for the coal to be burned. If high capacity from certain units were needed, the stoker was made wider. These short stokers resulted in a

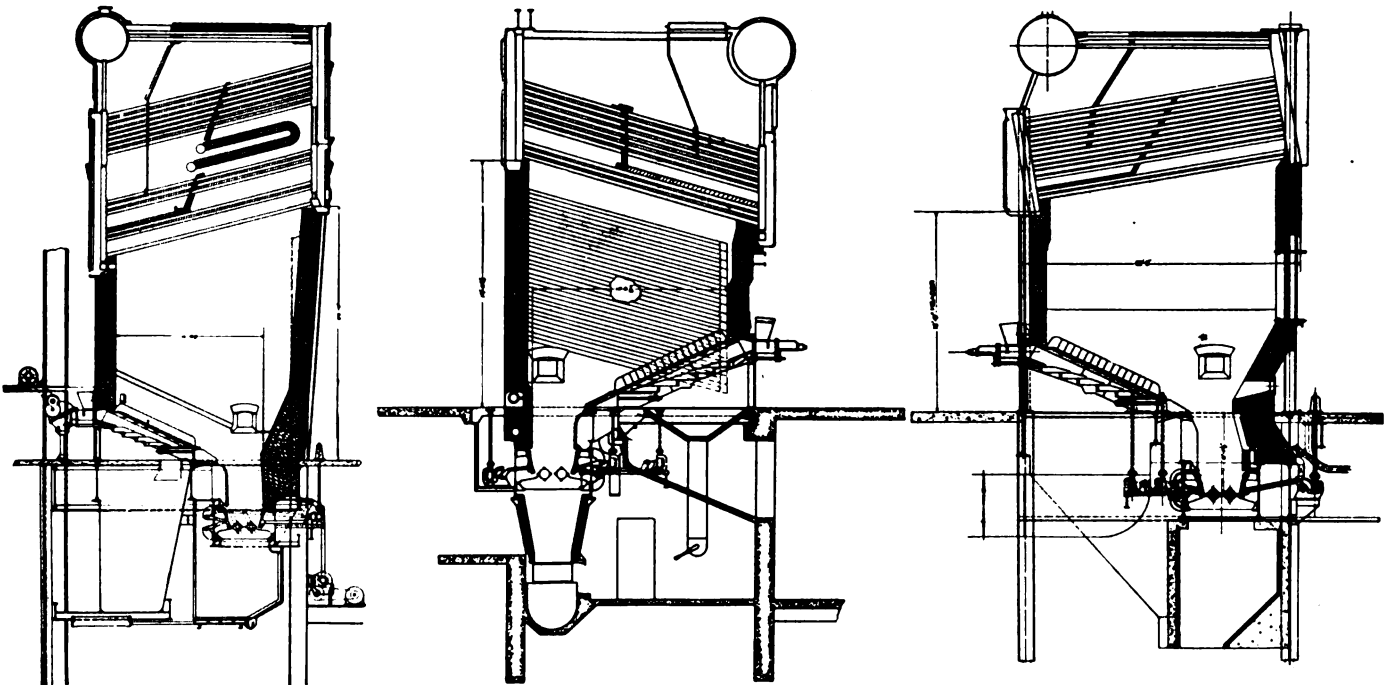


FIG. 4.—(Left)—Application of underfeed stoker to boilers for Weymouth Station of the Edison Electric Illuminating Company. Engineers, Stone & Webster, Inc. FIG. 5.—(Center)—Application of a hydraulic type underfeed stoker at Consumers Power Company, Milwaukee. Engineers, Commonwealth Power Company. FIG. 6.—(Right)—Hydraulic underfeed stoker application for burning Western high ash coals with rotary ash discharge for the River Side Power Manufacturing Company at Iowa. Engineers, United Light & Power Company.

very high loss from combustible in the ash. The coal was burned quickly at a high rate and as it reached the rear of the stoker, it was discharged into the ash pit.

In planning the modern stoker, the length of stoker that will give the lowest per cent of combustible in the ash should be used. Stokers are now being made from 17 ft. to 18 ft. from the front wall to the bridge wall where previously they were made 8 ft. or 9 ft.

A review of some of the modern stoker installations recently installed or about to be installed will be interesting from the viewpoint of the use of long stokers.

Hell Gate Plant—United Electric Light & Power Company.

This is probably one of the highest types of stoker-boiler combination of engineering designing in the country. The first stokers installed at this plant were double ended fired but by the introduction of the long stoker, the later units were equipped with single ended stokers. The 12 stokers originally installed were 14 retort underfeed stokers, 17 tuyeres long with the double rotary ash discharge between them. Each boiler had a furnace width from sidewall to side wall of 24 ft. 9 in., and the depth between each end wall of 19 ft. 1 in.

The latest installation consists of 14 retort, 33 tuyere stokers, Fig. 2, with a dimension of 15 ft. 6 in. from the front wall to the bridge wall. The side walls of this new furnace consist of water tubes arranged vertically with welded fins filling the space between them. The lower part of the tubes at a distance a little above the fuel bed line is covered with fire brick tile.

Tests on this installation show 92.7 per cent combined efficiency of boiler, superheater and economizer when burning coal containing 14,563 Btu. An analysis of the combustible in the ash shows that the combustible runs about $4\frac{1}{2}$ per cent which showed a heat loss of about 0.4 of 1 per cent, as shown in the foregoing heat balance.

Kearny Station, Public Service Production Company.

This plant, which is now being installed, is of particular interest because the stokers are probably the largest that have ever been built, Fig. 1—this not being entirely due to its width but its depth and also the distance from the clinker grinder rolls to the top of the coal hopper.

This stoker setting, Fig. 3, is designed to give 350 per cent of rating with efficiencies over 80 per cent. The power to operate this large stoker, when running without a fuel bed is 1.3 hp.

Weymouth Station, Edison Electric Illuminating Company, Boston.

Many engineering innovations are designed into this plant. This is one of the first applications of the long stoker in modern power house construction. The stokers are 29 tuyeres long and are built to handle 20 tons of coal per hour. These stokers burn a very dry coal of approximately 14,500 Btu. and are designed to run continuously at 350 per cent of boiler rating. Fig. 4.

Saginaw River Plant, Consumers Power Company.

Advances made recently in efficient stoker steam generating plants with high capacity output is ex-

emplified in the design of this plant. The station was purposely and intentionally laid out with guaranteed units so that one pound of good West Virginia coal would be used for each kw. of net output.

The boilers installed are 927 hp. (Fig. 5), and although the plant has only been running a short time, high efficiencies are shown to be possible and it is expected to obtain 140,000 lbs. of steam from each of the boilers.

The side walls are equipped with water cooled tubes which take the place of the ordinary brick furnace walls. The stokers are driven by hydraulic rams through a medium of oil pressure.

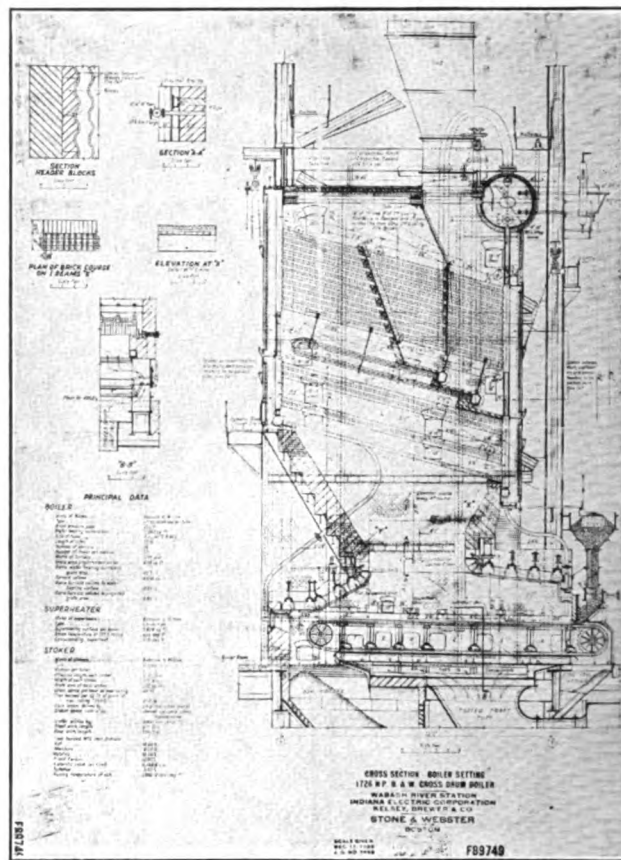


FIG. 7.—Typical application of forced draft chain grate stokers for burning middle western coal.

United Light & Power Company, Iowa, Ia.

One of the most interesting modern stoker steam central station installations, is the one now being built on the Mississippi River near Davenport, Ia., where underfeed stokers will be used. This stoker, Fig. 6, is designed to burn a poor grade of Illinois and Iowa coal, and is designed for high modern efficiencies. Instead of using a crank shaft for driving the plungers of these stokers, oil cylinders will be used in connection with what is known as a Hele-Shaw pump.

Chester Plant, Delaware County Electric Company.

This installation is unique in that provisions are being made so that preheated air up to about 500 deg. F. to 600 deg. F. can be used in connection with the stokers. The stoker is being especially designed for this kind of service. The coal to be used will be bituminous coal and high thermal efficiencies are calculated as the performance results.

Richmond Station, Philadelphia Electric Company.

This new plant of the Philadelphia Electric Company, possibly to be the largest station in the world, will start out with twelve 1,569 hp. boilers. The stokers will be of the long underfeed type and designed for preheated air.

Wabash River Station, Indiana Electric Corporation.

A typical installation of the application of forced draft chain grate stokers to large boilers is shown in Fig. 7. It will be noted that the effective length of the stoker is 21 ft. 3 in. With this kind of installation, high thermal combined boiler and stoker results is possible and about 250 per cent of boiler rating for capacity.

November Contents General Electric Review**Editorial—Scientific Crystal Gazing.**

Operation of 1,200-lb. Pressure Generating Unit at the Weymouth Power Station, Edison Electric Illuminating Company, Boston—By E. W. Norris, Stone & Webster, Inc. Great engineering interest is attached to the 1,200-lb. turbine-generator, of approximately 3,000 kva., described in the article, for it will be the first of so high a pressure to be placed in commercial service in this country.

New Type of Single-Phase Locomotives for the N. Y., N. H. & H. R. R.

The Field of Research in Industrial Institutions—By E. W. Rice, Jr. Research in the realms of pure science and in the current problems of production has given birth to new branches of industry, has fairly revolutionized production methods in existing industries to their great advantage, and is fundamentally perfecting the products of manufacture.

The Charles A. Coffin Foundation Award to the Northern Texas Traction Company.

The Remote Operation of Valves and Gates—By R. H. Rogers. In this article the author deals with the service of electricity in the remote operation of valves and gates. An unusually interesting example of this application of electric power is illustrated at the locks of the New York State Barge Canal, where the control of the valves and gates stands out in sharp contrast to the manual operation of those of the Erie Canal.

The Importance of Standards in the Evaluation of Insulating Materials — By Lawrence E. Barringer. The great difficulty of formulating tables of properties which can be safely used either for comparison or for determining the form and amount of insulation to be used.

Study of Crystal Structure and Its Application—By Wheeler P. Davey. This is the opening installment of a series of articles that will develop into an up-to-date treatise on crystal structure as determined by x-rays and will become an invaluable guide to its diversified applications.

Studies in the Projection of Light—Part XIV.—By Frank Benford. In this installment the author discusses the influence of manufacturing errors on the projection of light from a paraboloidal mirror.

The Sheathed Electrode and an Example of Its Application to the Automatic Welding of Galvanized Tanks—By B. C. Tracey.

Salient Features of the Power Show**Third National Exposition of Power and Mechanical Engineering Opens December 1**

The Power Show functions as a clearing house of information about the recent developments in power and mechanical engineering. The exhibits include machinery and equipment for the generation and utilization of power and the development of the arts and sciences of mechanical engineering. It includes boilers, stokers, superheaters, economizers, air preheaters, prime movers, pumps, condensers, valves, control apparatus, measuring instruments, materials handling equipment, transmission equipment, such as ball-bearings, clutches, belting, etc., machine tools, refrigerating machinery and heating and ventilating equipment. The exhibits will be of interest to all industries which use heat or power in any form or have any problems in mechanical engineering.

Lectures.

Lectures will be given by outstanding men on the following subjects: The Boiler Room, Steam Prime Movers, Oil and Gas Engines, Hydroelectric Power Plant Equipment, Materials Handling, Modern Machine Tool Developments, Mechanical Power Transmission, Mechanical Refrigeration, Heating and Ventilating. These lectures will not conflict with the technical sessions of the annual meeting of The American Society of Mechanical Engineers, which will be held in the Engineering Societies Building from December 1 through 4, or the meeting of the American Society of Refrigerating Engineers, which will be held from December 2 through December 4 at the Hotel Astor.

An elaborate program of films of general engineering and industrial interest will be shown. Educational exhibits showing the development of various forms of mechanical engineering equipment will be shown. There will be a showing of the historical development of machine tools.

Last year 62,079 engineers, operating men, manufacturers, industrialists, financiers, educators and students attended the Exposition. The first year the attendance was 47,580.

The Exposition is administered by the International Exposition Company, the managers of which are Fred W. Payne and Charles F. Roth, with offices in the Grand Central Palace.

The management is assisted by an advisory board composed of consulting engineers and representatives of The American Society of Mechanical Engineers, the American Society of Refrigerating Engineers, the American Society of Heating and Ventilating Engineers, the National Electric Light Association and the National Association of Stationary Engineers.

The following is a list of the exhibitors at the power and mechanical engineering exposition with the numbers of the booths occupied:

Space	Name
319-320	Aero Pulverizer Company.
75	Allen-Sherman Hoff Company.
58	American Arch Company.
74	American Schaeffer & Budenberg Corporation.
208	Armstrong Cork & Insulation Company.
38	Ashton Valve Company.
65	American Brass Company.
260	Armstrong Machine Works.
95-a	Andale Engineering Company.
65	Anaconda Copper Mining Company.
74	American Steam Gauge & Valve Company.
48	American Chain Company.

- 204 Alberger Heater Company.
 213-214 Arca Regulators Inc.
 212 Alsop Engineering Company.
 260 Advance Engineering Company.
 539 Ackerman Johnson Company.
 60 Ashcroft Manufacturing Company.
 495 American Blower Company.
 413 Andresen Company.
 412 Ames B. C. Company.
 552-553 Atwood & Morrill Company.
 432 American Pulverizer Company.
 429 Alexander Brothers.
 558 Blacker Engineering Company.
 54-55 Bailey Meter Company.
 16 Baker Dunbar Company
 249 Ballwood Company.
 313 Barnes & Jones.
 312 Bassick Manufacturing Company.
 50-51 Beaumont R. H. Company.
 78 Bernitz Furnace Appliance Company.
 70-71 Bethlehem Shipbuilding Corporation.
 68 Bigelow Company.
 340-341-342 Boston Gear Works.
 247 Bradley Washfountain Company.
 44-a Bridgeport Brass Company.
 12 Bristol Company.
 323 Brown Instrument Company.
 276 Builders Iron Foundry.
 8 Bundy Steam Trap Company.
 "A" Burhorn Edwin Company.
 90 Babbitt Steam Specialty Company.
 28 Brown Engineering Company.
 280 Boiler Kote Company.
 550 Boiler & Equipment Supply Corporation.
 543 Buffalo Forge Company.
 544 Buffalo Steam Pump Company.
 290 Budd Grate Company.
 547 Barco Manufacturing Company.
 427-428 Bartlett Hayward Company.
 550 Bayer Company.
 550 Bayer Steam Soot Blower Company.
 413 Blast Furnace & Steel Plant.
 423 Brady Conveyors Corporation.
 437 Blackburn Smith Corporation.
 263 Cambridge & Paul Inst. Company of America.
 285 Carr Fastener Company.
 566 Philip Carey Company.
 22 Carborundum Company.
 14 Celite Products Company.
 2 Chapman Valve Manufacturing Company.
 343 Clark, James, Jr., Electric Company.
 300-301-302-303-304-305 Climax Engineering Company.
 337 Clipper Belt Lacer Company.
 67 Cochrane Corporation, H. S. B. W.
 15-B Coen Company.
 53 Combustion Pub. Corporation.
 92 Connelly D Boiler Company.
 440 Chatillon, John & Sons.
 43 Connery & Company, Inc.
 32 Coppus Engineering Corporation.
 52 Crane Company.
 261 Crane Packing Company.
 277-278 Crosby Steam Gage & Valve Company.
 17 Carling Turbine Blower Company.
 79 Craig Damper Regulator Company.
 28 Cash, A. W., Company.
 241-242 Cory, Chas., & Son, Inc.
 286 Culm-Burn Equipment Company.
 543-544 Carrier Air Conditioning Company of America.
 328 Continental Valve & Equipment Company.
 69 Consolidated Safety Valve Company.
 423 Carrick Engineering Company.
 329 Conner Wm. B., Inc.
 23 Combustion Engineering Company.
 410 Campbell Andrew C., Inc.
 92 Cleveland Worm Gear Company.
 441 Central Forging Company.
 509 Columbus Machine Company.
 512 Diamond Chain Manufacturing Company.
 36-37 Davidson, M. T., Company.
 248 Dampney Company of America.
 10 D'Este, Julian, Company.
 13 Dearborn Chemical Company.
 488 Durabla Manufacturing Company.
 222 Detroit Belt Lacer Company.
 206-207 Detroit Stoker Company.
 94 Detrick, M. H., Company.
 27 Dodge, F. W., Corporation.
 41 Drake Non-Clinkering Furnace Blk. Company.
 17 Diamond Power Specialty Company.
 508 Dixon, Joseph, Crucible Company.
 208-a Dodd Mead & Company.
 423 Dickson, Walter S., & Company.
 486 Dick, R. & J., Company, Inc.
 12-a Eastern Steam Specialty Company.
 288-289 Edge Moor Iron Company.
 271-272-273 Elliott Company.
 44-B Ellison, Lewis M.
 18 Engineer Company, The
 217-218 Erie City Iron Works.
 100-101 Everlasting Valve Company.
 30 Edward Valve & Manufacturing Company.
 76 Ernst & Company.
 28-a Engineers Book Shop.
 531 Fairbanks Company.
 246 Fafnir Bearing Company.
 338-339 Falk Corporation.
 15-a Fisher Governor Company.
 315 Flexible Steel Lacing Company.
 84 Foster Engineering Company.
 62 Foxboro Company, The
 14-a and 14-b Fuller-Lehigh Company.
 252-253 Fulton Company, The
 92 Frederick Iron & Steel Company.
 46 Flynn & Emrich Company.
 17 Falls Engine Stop Company.
 41 Furnace Engineering Company.
 425-426 Farnsworth Company.
 326-327-330-331 Fairbanks Morse & Company.
 540 Foote Bros. Gear & Machine Company.
 226 Filtration Engineers Inc.
 438 Federal Gauge Company.
 564 Filtrators Company, The
 274-275 Gifford Wood Company.
 262 Girtanner Engineering Corporation.
 92 Gordon, James T., Company.
 35 Graver Corporation.
 201-202-203 Green, A. P., Fire Brick Co.
 49 Griscom-Russell Company.
 23 Green Engineering Company.
 87-88 Gillis & Geoghegan, Inc.
 542 Garlock Packing Company.
 546 Garratt Callahan Company.
 4-5 Goodman Manufacturing Company.
 557 Hanson Tap & Gauge Company.
 557 Hanson-Whitney Machine Company.
 46 Hand Stoker Company.
 92 Hagan Corporation.
 88 Hill Clutch Mch. & Foundry Company.
 204 Howard Iron Works.
 81 Huyette, Paul B., Company.
 81 Hays, Joseph W., Corporation.
 67 Harrison Safety Boiler Works.
 230 Howden, James, & Company of American.
 502 Hoff, M. A. Company.
 544 Hollow Ball Company.
 10 H. & O. Chain Company.
 60 Hancock Inspirator Company.
 60 Hayden & Derby Manufacturing Company.
 441 Hydraulic Press Manufacturing Company.
 509 Hytest Machine Company.
 39 Industrial Power.
 23-24-25 International Combustion Engr. Corporation.
 9 International Nickel Company.
 283-284 International Correspondence Schools.
 485 Irving Iron Works Company.
 314 Industrial Management Group.
 423 Illinois Engineering Company.
 506 International Filter Company.
 551 Insulating Material Company.
 90 Jenkins Bros.
 93 Jointless Fire Brick Company.
 412 Jones & Lamson Corporation.
 510-511 Jones, W. A., Foundry & Machine Company.
 211 Keeler, E., Company.
 296-297 Key Boiler Equipment Company.
 8-a Keystone Lubricating Company.
 11 Keystone Refractories Company.
 95 King Refractories Company, Inc.
 19 Kissick Fenno Company.
 317 Klingerit, Inc.
 530 Korfund Company, Inc.

- 72 Kellogg, M. W., Company.
566 Keasby, Robert A., Company.
91 Ladd, George T., Company.
86 Lead Lined Iron Pipe Company.
63 Lunkenheimer Company.
271 Lagonda Manufacturing Company.
272 Liberty Manufacturing Company.
203 Liptak Fire Brick Arch Company.
307 Locke Regulator Company.
225 La Bour Company.
24 Lopulco Company.
13 McLeod & Henry Company.
321 McVicker, W. B., Company.
411 McCrosky Tool Company.
226 M. & M. Engineering Company.
34 Mack Engineering & Supply Company.
60 Manning Maxwell & Moore Inc.
40 Manufacturers Record.
280 Maphite Sales Corporation.
209-210 Marion Machine Foundry & Supply Company.
258 Mason Regulator Company.
237-238-239 Merrick Scale Manufacturing Company.
267 Merco-Nordstrom Valve Company.
322 Midwest Air Filters Inc.
265 Morse Chain Company.
334-335-344-345 Morse Dry Dock & Repair Company.
254 Moto Meter Company Inc.
12-a Metallo Gasket Company.
79 Murphy Iron Works.
322 Midwest Steel & Supply Company, Inc.
216 Marlin Rockwell Corporation.
541 Management & Administration.
501 Mueller Company, Inc.
500 Mueller Metals Company.
268 Midwest Piping & Supply Company.
424 Mason, Volney W., Company.
411 Modern Machine Tool Company.
66 Nash Engineering Company.
82 National Engineer.
93 Neemes Foundry Inc.
346-347 New Departure Manufacturing Company.
234-235 Norma Company of America.
324-325 Norton Company.
341 Nicetown Ball Bearing Company.
95-a Nicholson, W. H., & Company.
82 N. A. S. E.
76 National Company.
19 Northern Equipment Company.
549 Nitrose Company.
8-B National Tube Company.
484 Niles Bement-Pond Company.
528 N. K. A.—Ball & Disk Bearings.
57 Otis Elevator Company.
227 Olsen Tinius Testing Machine Company.
228 Orange Bearing Company.
16 Payne Dean, Limited.
47 Peabody Engineering Company.
287 Pennsylvania Crusher Company.
13 Permutit Company.
10 Philadelphia Gear Works.
4 Pittsburgh Valve Fdry. & Const. Company.
556 Perolin Company.
42 "Power".
20 Power Specialty Company.
219-220 Preferred Utilities Company, Inc.
306 Pyramid Iron Products Corporation.
91 Pittsburgh Testing Laboratory.
98 Power Plant Engineering.
262 Perfection Grate & Supply Company.
48 Pratt & Cady Company.
343 Porter-Richards Machinery Company.
505 Power Transmission Company.
484-483 Pratt & Whitney Company.
504 Powell, Wm., Company.
89 Quigley Furnace Specialties Company.
496 Queen's Run Refractories Company.
3 Racine Tool & Machine Company.
292-293 Ramsey Chain Company.
48 Reading Steel Casting Company.
316 Reed Air Filter Company, Inc.
6 Republic Flow Meters Company.
240 Richardson Scale Company.
215 Robinson, John R.
11-a Roto Company.
81 Reliance Gauge Column Company.
548 Ren Manufacturing Company.
291 Research Engineering Corporation.
536 Roberts Steam Specialty Company.
25 Raymond Bros. Impact Pulv. Company.
411 Rockford Machine Tool Company.
219 Ray, W. S., Manufacturing Company.
503 Stroh Steel Hardening Process Company.
336 Sandvik Steel, Inc.
79 Sanford Riley Stoker Company.
33 Sarco Company, Inc.
318 S-C Regulator Manufacturing Company.
69 Scovill Manufacturing Company.
332-333 SKF Industries, Inc.
255 Seminole Chemical Company.
76 Simplex Valve & Meter Company.
281-282 Smidth, F. L., & Company.
85 Smith & Serrell.
10 Southern Engineer.
76 Sowdon, W. H.
28 Spence Paulsen Company.
31 Springfield Boiler Company.
26 Stewart Sayers Company.
56 Superheater Company, The
27 Sweet's Engineering Catalog.
17 Smith Gas Engineering Company.
28 Sterling Engineering & Equipment Company.
26 Sharples Specialty Company.
534-545 Schutte & Koerting Company.
535 Safety Equipment Service Company.
229 Swartwout Company, The
245 Standard Steel & Bearings, Inc.
554-555 Skinner Bros. Manufacturing Company.
532 Strom Ball Bearing Manufacturing Company.
76 Skeen, D. H., & Company.
59 Tagliabue, C. J., Manufacturing Company.
98 Technical Publishing Company.
256-257 Techno Service Corporation.
95-a Tide Water Oil Sales Corporation.
28 Templeton Manufacturing Company.
264 Temperature Control Company.
222 Thomas Flexible Coupling Company.
507 Taylor Instrument Companies.
497 Topping Company.
560 Thompson, Henry G., & Son Company.
505 Transmission Ball Bearing Company.
412 Triplex Machine Tool Company.
498 Toledo Scale Company.
538 Talcott, W. O. & M. W., Inc.
499 Toledo Pipe Threading Machine Company.
497 Topping Brothers.
45 Uehling Instrument Company.
79 United Machine & Manufacturing Company.
79 Underfeed Stoker Company of America.
79 Underfeed Stoker Company of Canada, Ltd.
439 Universal Coal Spreader Company.
442-443 Universal Fixture Company.
17 Vincent Gilson Engr. Company.
268-269-270 Vogt, Henry, Machine Company.
279 Voss, J. H. H.
19 Vulcan Soot Cleaner Company.
244 Vasil Steam Systems Company.
533 Vacuum Oil Company.
221 Wailes Dove-Hermiston Corporation.
250-251 Walsh & Weidner Boiler Company.
308-309-310-311 Walworth Manufacturing Company.
223-224 Warren Webster & Company.
77 Wheeler, C. H., Manufacturing Company.
64 Wheeler Condenser & Engineering Company.
61 Wing, L. J., Manufacturing Company.
286 Wolff & Munier Inc.
236 Wright-Austin Company.
76 Williams Gauge Company.
309 Watts Regulator Company.
266 Waite & Davey Company.
231 Warren Steam Pump Company.
99 Wayne Tank & Pump Company.
557 Whitney Manufacturing Company.
529 Westco-Chippewa Pump Company.
528 Wollman Engineering Company.
259 "X" Laboratories.
7-a and 7-b Yarnall-Waring Company.
493-494 Yale & Towne Manufacturing Company.

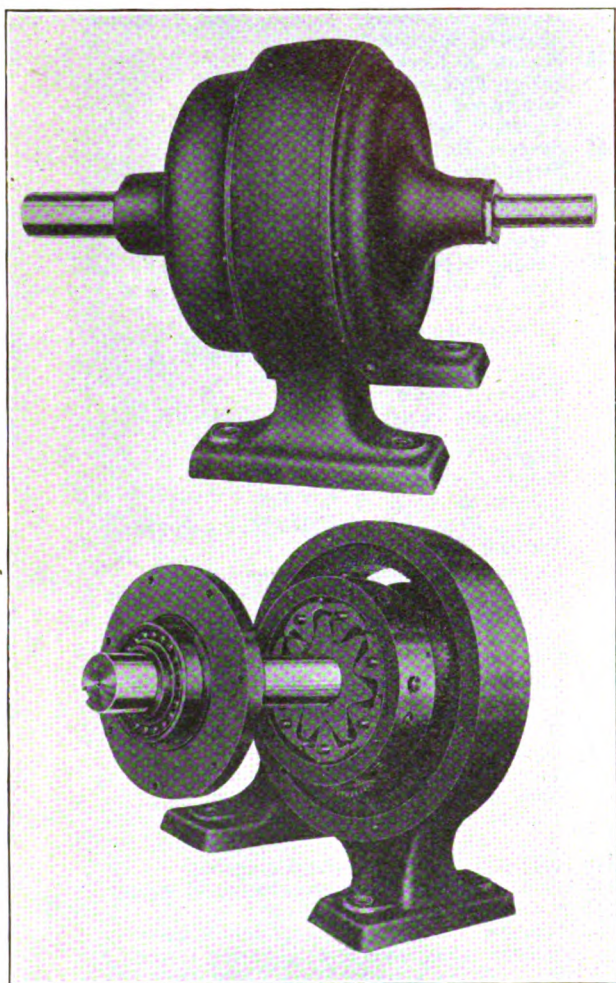
Booths 1-101 are located on Main Floor; booths 200-347 are located on Mezzanine Floor, and booths with higher numbers are located on Third Floor.

WITH THE EQUIPMENT MANUFACTURERS

New Speed Reducer With Several Interesting Features

High speed turbines and motors, which are rapidly coming into general use because of their compactness and economy, require a speed reducing mechanism when driving low speed machinery, such as compressors, generators, refrigerating machines, pumps, conveyors, crushers, etc.

The ideal speed reducer should transmit the load noiselessly, without shocks or loss of power, and should be compact and require minimum attention.



A speed reducer has been recently developed that meets these requirements in a novel manner. The load is transmitted from the high speed shaft through planetary gears to a slower rotating annular ring. Inside this ring are connected a number of rockers which engage with a spider keyed to the low speed shaft.

As the driving motor or turbine starts up, each of the rockers engaging with the teeth of the spider, first compresses a spring plunger which brings the bottom of the rocker into positive contact with the inside of the annular ring and at the same time brings

its side into positive contact with the side of the adjacent spider tooth.

During the time required to compress the spring plungers, corresponding to about one-quarter of a revolution, there is practically no load on the turbine or motor, and the load is then transmitted gradually and without starting shock. The spring plungers also serve to eliminate vibration and backlash, thereby assisting quiet operation.

The low speed shaft to which the spider is keyed is supported on both sides of the spider. The pinion on the high speed shaft is allowed to float and adjust itself to the proper position between the planetary gears, thus preventing side strains or unequal stresses and assuring perfect torque.

The speed reducer is totally enclosed, so as to be dust-proof and fool-proof, and all parts run in oil, with forced lubrication above 1800 rpm. It can be applied to either step-up or step-down speed change, and is furnished in ratios from 4:1 to 200:1 and for any load up to 500 hp. Full information as to its application to specific requirements can be obtained by writing The Meachem Gear Corporation, 122-142 Dickerson street, Syracuse, N. Y.

Modern Couplings

The fact that Fast's Flexible Coupling is different—entirely different—from ordinary couplings is responsible for its use by Westinghouse, General Electric, Carnegie Steel and others for more than ten-million hp. in the last five years.

A recent bulletin issued by the Bartlett Hayward Company shows the outstanding features of Fast's design: double-engagement, positive lubrication, no flexible materials to fatigue and limit the life of the coupling; how it is self-aligning, mechanically compensating for all errors of shaft alignment.

Owing to the greatly increased demand for Link-Belt products and close range service, the Link-Belt Company has erected a new warehouse and office building at 5938 Linsdale Avenue. The building recently being completed, the Detroit branch has moved to their new home, from their former quarters on Woodward Avenue.

The new structure is two stories and houses not only the general office for the Detroit branch but a large warehouse where standard Link-Belt and H. W. Caldwell & Son Company, products are kept in readiness for immediate shipment. This stock includes the various types of chains for elevating, conveying and power transmission purposes, sprockets, clutches, malleable iron elevator buckets, etc.

In commenting upon the acquisition of the new home, B. H. Lundahl, manager of the Link-Belt Detroit Office, said: "Our Detroit office has grown with the City of Detroit and we are very optimistic regarding our future."

TRADE PUBLICATIONS AND NOTES

100 and 1 Ways to Save Money

The successful contractor of today can no longer figure merely on the "pick and shovel" way but must use labor aiding machines to reduce his cost wherever possible. He needs better, faster and cheaper methods. Companies doing their own work also need modern tools and improved methods for construction and maintenance operations which must be finished quickly and with minimum hand labor.

Compressed-air operated tools, driven by air from a portable or semi-portable compressor, have proved great labor-savers in road-building, trench and tunnel digging, pipe work, steel erection and repair, rock excavation, backfill-tamping and in similar work. The Ingersoll-Rand Company through its development of rock drills, trench diggers, tie tampers, paving breakers, and special applications of sand rammers, calking hammers and other pneumatic tools, can now furnish compressed air operated tools for a great many operations. Each of these air operated tools will do the work of from three to ten or more men. Modern air compressors, either portable or semi-portable for operating these tools, have been developed, so that complete Ingersoll-Rand equipment can be furnished for any job.

Greater profits can be made on hundreds of jobs by adding a portable compressor and air tools to the regular equipment, thus reducing the man-hours required. The pages of Ingersoll-Rand's latest bulletin show how I-R machines have been used on various classes of work and how they have made pronounced savings.

A unique application was recently made of a small forge blower manufactured by the American Blower Company, known as their Size A, Type "P".

Robert Oakman's 120 ft. yacht, "Mamie O", is equipped with two 180 hp. full Diesel engines. The gases generated by these engines caused a very disagreeable condition in the engine room, which is naturally small.

To relieve this condition, the inlet of the fan was provided with a flange and a 3 in. steel pipe run to the crank case of each engine, for the purpose of exhausting the gases from them and discharging same outside of the boat.

This has overcome entirely the objectionable features. Bulletin 56, Series 1, describes this blower.

Underfeed Stoker Company, Ltd., of Great Britain, an associated company of the International Combustion Engineering Corporation, has just received an order for six chain grate stokers of the self-contained type from one of the largest paper mills in Holland.

These are similar to the stokers recently ordered by the Montreal Tramways from the Combustion Engineering Corporation, Ltd., of Canada, a subsidiary of International, and are being introduced in

the States by the Combustion Engineering Corporation of America.

This order is one of a series from the same concern which has been gradually replacing other types of stokers with these machines after assuring themselves of the economies therefrom by practical experience with earlier installations—this order being the last of a series with their mill, aggregating twenty-four machines.

H. W. Thompson, formerly sales manager for Bardons & Oliver, has been elected a vice president of the George T. Trundle Engineering Company, Cleveland, O., in charge of promotion. He will assume his duties with that company on December 1, 1924.

Large Gear Drives

A list of the steel plants in which Mesta Double-Helical Cut Tooth Gear Drives have seen years of hard service sounds like the roll call of the Sheet Steel Association.

Bulletin "B", just off the press, is being distributed by the Mesta Machine Company.

Excellent photographs illustrate the enormous size of some gears, and views of the interior of the Mesta machine shops indicate very clearly their exceptional production facilities. The accuracy of the teeth in large double-helical gears and pinions is of prime importance, as the life of such moving members is determined largely by uniformity of pitch and accuracy of the tooth profile. Bulletin "B" explains fully. There is also a page devoted to Mesta Flexible Couplings.

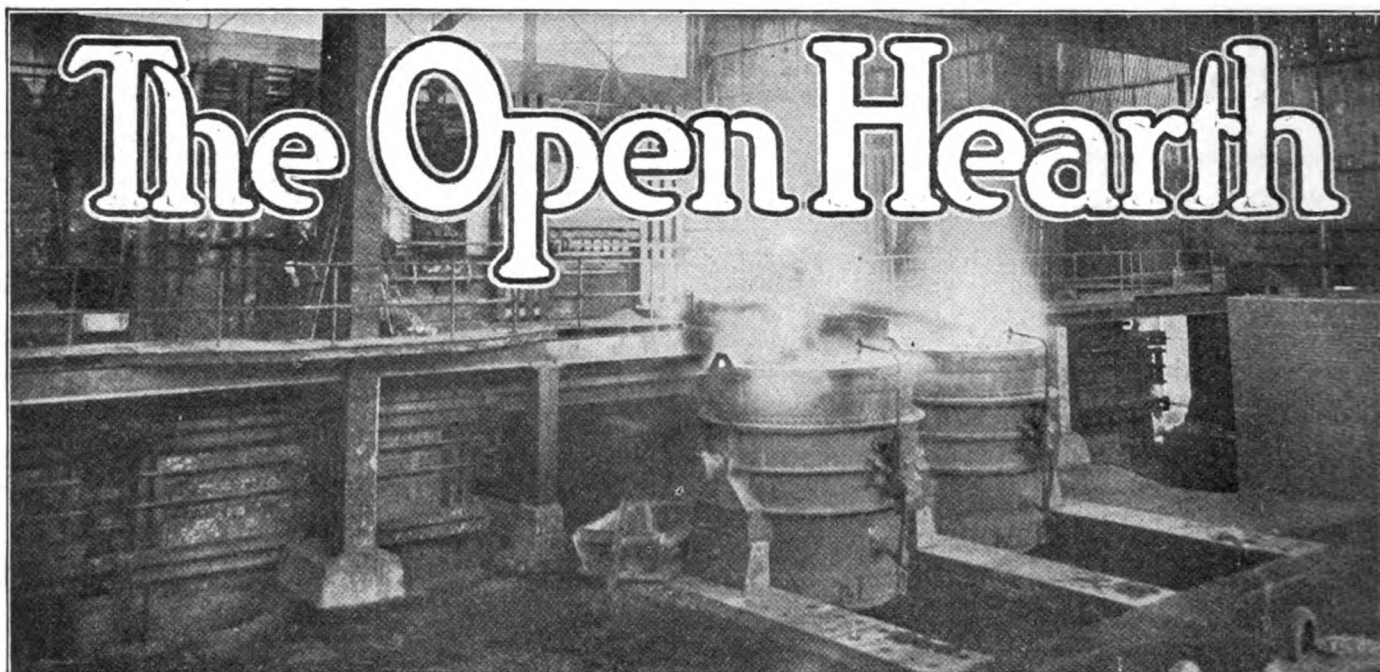
Mesta Una-Flow Engines

The story of a discussion held in 1903 between the chief engineer of a well-known building company and the superintendent of a well known steel plant illustrates the importance of the time element in engine replacements.

Bulletin V-2 demonstrates the very great economies possible where Una-Flows are installed.

Reeves Brothers Enter the South

The Reeves Brothers Company, Alliance, Ohio, has acquired a tract of about 40 acres of land at Birmingham, Ala., and has authorized plans for the immediate construction of a new steel fabricating plant to occupy a considerable portion of the site. A contract for buildings has been let to the McClintic-Marshall Company, Pittsburgh, Pa. The initial works will be designed to give employment to close to 200 men, and are estimated to cost in excess of \$750,000, including machinery. A considerable portion of the equipment will be transferred from the present Alliance plant, and additional equipment purchased at an early date. It is stated that the plant will be ready for service early in the spring of the coming year.



Dr. Carl Benedicks, director of the Metallographic Institute of Stockholm, Sweden, will deliver the annual lecture before the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers at its annual meeting, the third week in February, 1925. Later Dr. Benedicks will visit several of the leading universities of the country, as well as some of the local chapters of the American Society for Steel Treating, and deliver addresses.

Thomas Adams has tendered his resignation as president of the Ashland Steel Company, Ashland, Ky. L. R. Putnam, who has been general manager of the company, also resigned his position, effective Nov. 1. Mr. Putnam will engage in the industrial insurance field. I. P. Blanton, president Belfont Steel & Wire Company, and vice president of the Ashland Steel Company, will have direction of the affairs of the company until the annual meeting in January. The Belfont Company now controls two-thirds of the stock of the Ashland Company.

Hans Thyssen of the well known firm of Thyssen & Company, Muelheim, Germany, arrived in New York this week, accompanied by several representatives of the Thyssen group of iron and steel works. They will investigate the possibilities of the American market as an outlet for German steel products. The plants in the Thyssen group have an annual capacity of 1,700,000 tons of pig iron and 1,300,000 tons of steel ingots.

Charles Piez, chairman Link-Belt Company, Chicago, has been elected president of the Illinois Manufacturers' Association.

H. A. Barren has been appointed general superintendent of the Jay Waldeck Company, assistant general superintendent of the American Steel & Wire Company, both appointments becoming effective November 11. Mr. Barren for a number of years has been manager of the company's blast furnaces in the Cleveland and Pittsburgh districts and as in the past, will divide his time largely between Cleveland and Pittsburgh. Mr. Waldeck has been manager of the company's wire mills in the Cleveland district.

Emil Winter, president Pittsburgh Steel Products Company and vice president of the Pittsburgh Steel Company, Pittsburgh, has been appointed a member of the Pittsburgh Art Commission to fill the vacancy created by the death of Willis McCook, who at the time of his death was president of the Pittsburgh Steel Company.

O. C. MacMillan, formerly assistant manager of the order department, Inland Steel Company, Chicago, has become associated with S. W. Lindheimer, Chicago, in the sale of rails, frogs and switches and track fastenings.

Marcus A. Grossmann has become affiliated with the metallurgical department of the United Alloy Steel Corporation, Canton, Ohio, in charge of the research division. Since his graduation from the Massachusetts Institute of Technology in 1911, Mr. Grossmann has been actively engaged in research work, specializing in alloy steels. He was formerly chief metallurgist of the Electric Alloys Steel Company and the Atlas Steel Corporation.

George G. Titzell, Jr., has been appointed assistant district sales manager in St. Louis of the Carnegie Steel Company, Pittsburgh. Mr. Titzell was formerly resident sales agent of the company at Kansas City. He succeeds Lawrence F. Miller, who recently resigned to become general manager of sales for the National Enameling and Stamping Company of St. Louis.

Official announcement of the resignation of Colonel Oscar H. Fogg, as secretary-manager of the American Gas Association was made at the regular monthly meeting of the executive board of the organization. Colonel Fogg, who has headed the gas association since 1919, leaves to assume the position of president and general manager of the Baltimore Gas Appliance and Manufacturing Company, Baltimore, Maryland.

The American Gas Association has a membership of more than 500 manufactured gas utilities in the United States and Canada.

Some Pointers on By-Product Coke Oven Operations

Special Small Size Coke Ovens

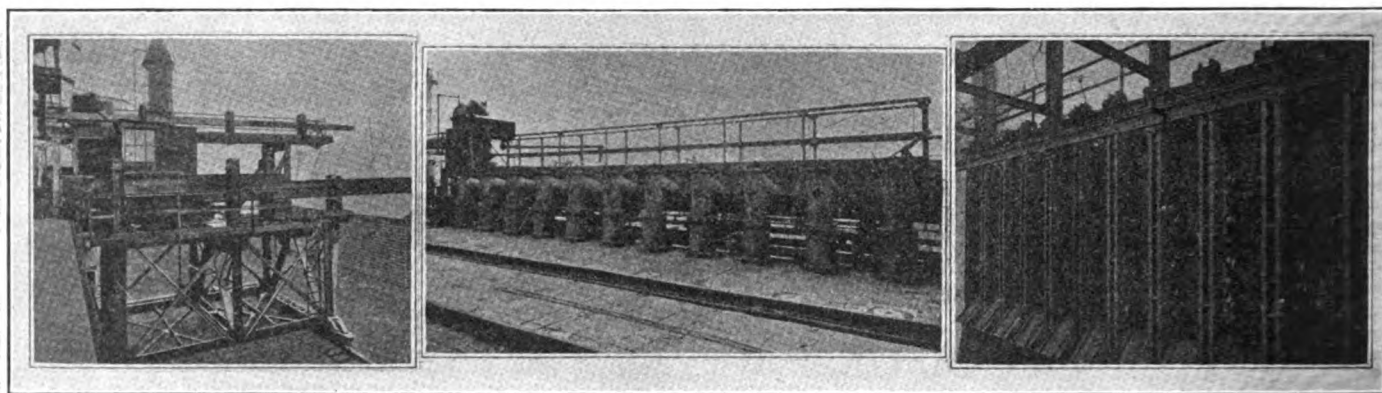
Five Ordinary Ovens Would Have Supplied Enough Gas for
Battle Creek

THE Battle Creek battery of eleven Becker-type ovens, each with a coal capacity of 6.8 tons per charge, was designed on principles clearly established first by the experimental battery of five ovens in the Chicago By-Product Coke Company plant. On a larger scale these ovens have been tried with success also in several other plants, notably in the 366-oven addition to the Clairton, Pa., plant of the U. S. Steel Corporation.

All these earlier batteries had, however, been full size "coke" ovens, heated with oven-gas from fuel gas lines on both sides of the battery, usually with a coal capacity of 12.5 to 16 tons per charge. Clearly only five or six such ovens would be sufficient for Battle Creek and a battery of as small a number as that was impractical except for experimental purposes. The obvious thing to do was, therefore, to use a smaller unit in larger numbers. This was done without loss of the essential elements of the larger oven, simply by

making the oven shorter, about 23 ft. inside length instead of 35 to 42 ft. as commonly found for coke ovens.

Reduction in oven length had numerous mechanical advantages. In the first place, a single fuel-gas line on one side of the battery serves to heat the entire length of the ovens. As the coal charge is smaller, a smaller larry car and corresponding lighter construction of battery machinery are possible. With shorter ovens and smaller charges, the coke-pushing, receiving and quenching equipment is correspondingly smaller and less expensive. These and other modifications in mechanical requirement all contribute to a lessening of initial costs for machinery without in any way affecting the certainty of operation, the quality of coke, or the yield and quality of by-products. In a word, the efficiency of large-unit production has been adapted to smaller plant conditions.—Chemical and Metallurgical Engineering.



Some details of the oven. At the top of the page the gas outlets from the individual retorts are shown leading into the gas main. Note also in the foreground the track on which the charging equipment is moved from oven to oven. Below on the left is the ram for pushing the coke out of the retorts into larry cars and on the right the doors through which the coke is pushed. Note the aprons and quick release clamps.

Monel Metal and Nickel Literature

Monel Metal and Rolled Pure Nickel have established an enviable record for service under unusually severe operating conditions. They are now recognized as the most important of the non-ferrous metals.

During years of study of the performance of Monel Metal and Rolled Pure Nickel under a wide range of conditions, there has been accumulated a great deal of valuable data. The list "B" shows some of the technical and trade literature, now available.

These bulletins may be secured from the International Nickel Company.

Bourne-Fuller Extensions

The Bourne-Fuller Company, Cleveland, Ohio, has work under way on extensions and improvements in its Upson blast furnace and steel plant. The stack is being relined and considerable additional equipment will be installed including a skip-hoist, ore and coke bins; and a battery of five soaking pits at the steel work. The project will comprise the construction of a new four-story steel and concrete plant unit, 72 x 175 ft., while a number of additional plant units will be added later. It is stated that the entire project will cost in excess of \$300,000, including equipment.

NEWS OF THE PLANTS

The Youngstown Sheet & Tube Company, Youngstown, Ohio, is perfecting plans for proposed additions to its plant at Indiana Harbor, Ind., in conjunction with a new blast furnace on which construction is now in progress. It is expected to have this unit ready for blowing in at the earliest possible date. The expansion program will include the construction of three new open-hearth furnaces, and extensions and improvements in the blooming mill, with the installation of considerable additional equipment of improved type. Other work comprises a wire rod mill to develop a capacity of about 10,000 tons per month; a wire plant, equipped for wire-drawing, nail manufacture, etc.; and a sheet and tin plate mill. The entire project is reported to involve close to \$5,000,000.

Re-organization plans are in progress for the Baldwins Canadian Steel Corporation, Toronto, Ontario, with plant in the Ashbridge Bay Industrial District, Toronto, to include considerable additional financing to provide for expansion in the present mills, including improvements in existing buildings and the installation of equipment. It is proposed to carry out the work during the winter months and have the enlarged plant ready for service early in the spring. The works have a present estimated output of 100,000 tons of steel ingots and castings per annum. It is planned to develop a large production in the line of plates and affiliated steel products, with the employment of close to 600 operatives. The company is affiliated with Baldwins, Ltd., of England, and which latter company is completing negotiations for the purchase of a portion of the plant of the McClary Manufacturing Company at Montreal, Quebec, to be used in connection with a proposed large works at this place for the manufacture of galvanized sheets. It is expected to perfect details at an early date, including the organization of a subsidiary to be known as Baldwins, Montreal, Ltd., and which will operate the proposed new works.

The Delaware River Steel Company, Chester, Pa., will proceed with improvements and extensions in its blast furnace, to include the installation of considerable additional equipment. The present unit is of hand-operated type and will be converted into a skip-filled unit. The equipment installation will include a trestle for handling steel stock with suspension type ore storage bins, coke bins, skip bridge, skip cars, scale cars and other auxiliary apparatus. Work is in progress on a new ore dock at the plant for the unloading of material; complete ore-handling machinery, hoisting apparatus, etc., will be installed.

The Savannah Steel Corporation, Savannah, Ga., recently organized with capital of \$200,000, by Elliott W. Reed, 302 Estill Avenue, Atlanta, Ga., and associates, is perfecting plans for the establishment of a new rolling mill and steel fabricating works at Port Wentworth, Ga. The company is said to have acquired a large tract of land at this location, fronting on the Savannah River, including a number of buildings used previously by the Terry Shipbuilding Company, including machine shop, power house, etc. It is pro-

posed to remodel and convert the existing buildings into the proposed steel works, with initial installation for a complete rolling mill for the production of bars, as well as structural shapes. The plant is estimated to cost approximately \$200,000, including equipment for which orders will be placed at once. It is purposed to expand the initial works in the near future. G. Leonard Allen, Savannah, is also an official of the organization.

The National Tube Company, Pittsburgh, Pa., will make improvements in its blast furnace No. 2 at its Benwood, W. Va., works, to include the installation of a revolving distributor and other miscellaneous equipment. Plans are also under consideration for other work at company mills.

J. J. Gray, operating a blast furnace at Rockdale, Tenn., has authorized plans for the construction of a new unit, using present site. The existing stack will be dismantled and replaced by a furnace about 70 ft. high, and will be designed primarily for the production of ferro-phosphorus, as ordinarily produced in an electric furnace and made possible under regular blast furnace operation by a special process. Ore will be secured from mines at Iron City, Tenn. It is planned to begin work at an early date and have the stack ready for service in the early months of the coming year. Arthur G. McKee & Company, Cleveland, Ohio, will design the unit and supervise the construction.

The Kansas City Steel & Wire Company, Kansas City, Kan., recently organized with a capital of \$750,000, has acquired the former plant of the McKenna Steel Working Company, located at Twelfth Street and the line of the Terminal Railroad, Armourdale district, Kansas City. Plans are under way for the complete remodeling of the works to include the construction of additional buildings, the latter consisting of two one-story structures, 100 x 150 ft., and 82 x 250 ft. The equipment installation will include 8 and 10-inch mills, two 50-ton open-hearth furnaces, cooling beds and auxiliary apparatus. The plant will be devoted to the production of steel bars, steel rods, and kindred products. The entire project is estimated to involve close to \$500,000. L. W. Conroy, formerly connected with the Lackawanna Steel Company, Buffalo, N. Y., and the Carnegie Steel Company, Pittsburgh, Pa., will be vice president and general manager of the new organization.

The Connors Steel Company, Birmingham, Ala., is reported to have plans under way for the rebuilding of the portion of its plant in the Woodlawn district, recently destroyed by fire, with loss reported at close to \$35,000, including equipment. New machinery will be installed to replace damaged apparatus.

George W. Baum, iron and steel manufacturing executive in the Pittsburgh district for 20 years, died late Wednesday night, November 26, at the age of 69. He was a director of the Mackintosh-Hemphill Company, and formerly served as vice president of the company. He was affiliated with other iron and steel interests and lately took an active interest in oil.



Positions Wanted and Help Wanted advertising inserted under proper headings free of charge. Where replies are keyed to this office or branch offices, we request that users of this column pay postage for forwarding such replies. Classified ads can be keyed for the Pittsburgh or New York offices.

POSITION WANTED

SUPERINTENDENT of sheet mill desires to make a change; has had years of experience in the rolling of light iron and high grade auto and metal furniture sheets; can furnish reference. Box X X X, care of The Blast Furnace and Steel Plant.

MELTER, 18 years practical experience. Open Hearth and Electric, leading European makers high grade steels, age 35, wants position where his knowledge and experience can be used. Highest references. Box 301, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Cold strip mill superintendent with thorough knowledge in operating. Can apply latest methods to produce highly finished material. Twenty years' experience; reliable references. Box 000, care of The Blast Furnace and Steel Plant.

MASTER MECHANIC with 30 years' experience on construction and operation of steel mills, blast furnaces, open hearths, Bessemer departments, by-product coke plants; constructed hydro and steam electric plants, large pumping stations, etc.; at present employed, wish to make change. Box 100, care of The Blast Furnace and Steel Plant.

CHIEF DRAUGHTSMAN—Broad and varied experience in general engineering, mechanical, structural, electrical, designing machinery, tools, power, structural steel, concrete and industrial buildings; purchase, installation and plant maintenance. Address Box A M B, care of The Blast Furnace and Steel Plant.

DESIGNING ENGINEER, experienced executive with technical training, desires position as chief engineer or master mechanic. Fifteen years' experience, including design and construction of rolling mills, furnaces, plant equipment, power plants, special machinery, etc.; four years in machine shop. Address Box F C M, care of The Blast Furnace and Steel Plant.

POSITION WANTED—A graduate mechanical engineer with 12 years' experience in rolling mills, desires a position as superintendent or assistant. Experience covers every job in a rolling mill from laborer to assistant superintendent. Also has had some office and sales training. At present employed, but desires a better outlook. Box C A S, care of The Blast Furnace and Steel Plant.

POSITION by chemist, technical graduate, 15 years experience glass, animal fats, bleaching iron and steel. Six years experience as plant executive. Research work a specialty. Box L, care of The Blast Furnace and Steel Plant.

YOUNG rolling mill superintendent with 20 years' practical experience on iron and steel Belgian type mills, also latest continuous type steel mills, desires to make change. Can furnish records and references. Have practical knowledge of rolling and roll designing. Box F A W, care of The Blast Furnace and Steel Plant.

ENGINEER, Cornell graduate, seven years' steam and fuel engineering, three years' executive experience as master mechanic of a rolling mill, three years' sales engineering, desires change. Box S, care of The Blast Furnace and Steel Plant.

POSITION WANTED

ENGLISHMAN, 23, of sound general and technical educations, with seven years' experience of steel making by open hearth process (acid and basic) in prominent English steel works, desires appointment where scientific and practical knowledge would be an asset. Box G B J, care of The Blast Furnace and Steel Plant.

WANTED—A position wherein the following will be of value: A fair technical education, a large amount of practical experience in the various mechanical arts and plant operation and maintenance, with an eye on the "works operating expense" account, a fair degree of executive ability and absolute dependability. Experience has been had in production and general machine shops, rolling mills, rod and wire mills and at blast furnaces. Expert in design and construction of the Dwight and Lloyd type of sintering plant. Box C C C, care of Blast Furnace and Steel Plant.

CHEMICAL ENGINEER, 1922 graduate, leading university, desires position in a steel plant. One year's experience in the inspection department. At present employed, but available on short notice. Box J B C, care of Blast Furnace and Steel Plant.

POSITION WANTED—Electric furnace man open for position; experienced on basic Heroult electric furnaces, tool and alloy steels. Box A T, care of The Blast Furnace and Steel Plant.

HEATER on soaking pits or reheating furnaces; 10 years' mill experience; can give references. Box C Z, care of The Blast Furnace and Steel Plant.

SALES POSITION with manufacturers' sales agent for power plant specialties or chief draftsman or plant engineer with moderate sized manufacture. Box K, care of The Blast Furnace and Steel Plant.

I DESIRE to have a position as tracer or on small drafting work with reliable concern, preferably in mechanical line. Box J, care of The Blast Furnace and Steel Plant.

YOUNG MAN, technical graduate and 7 years practical experience, would like to connect with organization needing a producer. Prefers a job which keeps him on the road the major portion of the time. He has intensive education along lines of general inspection of materials. Box I, care of The Blast Furnace and Steel Plant.

POSITION as field engineer, construction work, general survey work and right-of-way work. Box G, care of The Blast Furnace and Steel Plant.

POSITION WANTED by chemical engineer, degree of doctor-engineer (1916) from leading German university, 33 years old, six years' experience embracing the analysis, metallography and physical testing of steel and alloys. Nationality, Norwegian. Languages, Norwegian, Swedish, German and English. Location, anywhere. Available, any time. Can furnish best of references. Box R E D, care of The Blast Furnace and Steel Plant.

TIME KEEPER—Have had several years experience. Box H, care of The Blast Furnace and Steel Plant.

YOUNG MAN with five years' experience as machinist and three years' experience in foundry, Tech graduate, wishes position with growing firm at or near Philadelphia, Pa. Box W B, care of The Blast Furnace and Steel Plant.

POSITION WANTED

CHIEF CLERK or assistant to works manager; 32 years old, married. Ten years' experience in sheet and tin rolling mills, galvanizing, long terne and factory record and office work. Experienced from time-keeping to corporation yearly statement, including cost. Box L E T, care of The Blast Furnace and Steel Plant.

ROLLING MILL superintendent, experienced in the heating and rolling of carbon, alloy and electric furnace steels, desires position; experienced in blooming, plate and universal mills. Highest references. Box A R T, care of The Blast Furnace and Steel Plant.

POSITION WANTED by experienced roll turner and designer. Have had several years' experience in charge of roll shops, designing, etc., as well as turning rolls. Have also had experience working on the mills. Can handle position of mill superintendent, roll designer or boss roll turner. Can furnish best of references. Box P V C, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Steel mill electrical engineer desires change in location. Five years' engineering and operating experience in steel mills. Technical graduate, member A. I. & S. E. E., Associate A. I. E. E.; age 32. Box A R L, care of The Blast Furnace and Steel Plant.

YOUNG MAN, technical education, desires position in Pittsburgh District as chemist on analysis of open hearth steels. The applicant is at present employed in steel work, but desires a connection offering greater possibilities. Details as to past experience and recommendations will be submitted on request. Box G P G, care of The Blast Furnace and Steel Plant.

WANTED—Position on maintenance in medium sized steel plant or factory; 12 years' drafting room experience on general mill engineering and three years' machine shop experience. Box F D J, care of Blast Furnace and Steel Plant.

POSITION WANTED—Blast furnace superintendent, twelve years practical experience as blast furnace master mechanic, general foreman and assistant superintendent, thoroughly familiar with metallurgy of iron, maintenance of plant, Bessemer, foundry, Spiegle, ferro silicon and ferro manganese, also up-to-date in best cost practice, technical education; employed at present. Address Box F W H, care of The Blast Furnace and Steel Plant.

PHOTOGRAPHER—Thoroughly competent to take charge of photographic department in industrial concern; experienced steel mill man; reference furnished. Address Box C B S, care of The Blast Furnace and Steel Plant.

FIELD ENGINEER, desires change. Technical training and nine years experience on construction and maintenance of steel plants; also general surveys; 30 years old and married. Box 200, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Assistant superintendent open hearth or bloom mill. Have had quite a number of years' experience in open hearth and bloom mill practice, believe in quality steel and can furnish best of references. Box T, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Chemist and engineer desires responsible connection; experienced in both blast furnace and steel plant. Box C A N, care of The Blast Furnace and Steel Plant.

Co-operate:—Refer to The Blast Furnace and Steel Plant

Keeping America Safe for Americans With Machines

Have the Divergent Religious, Social, Governmental Instincts
Prevented Real Assimilation?

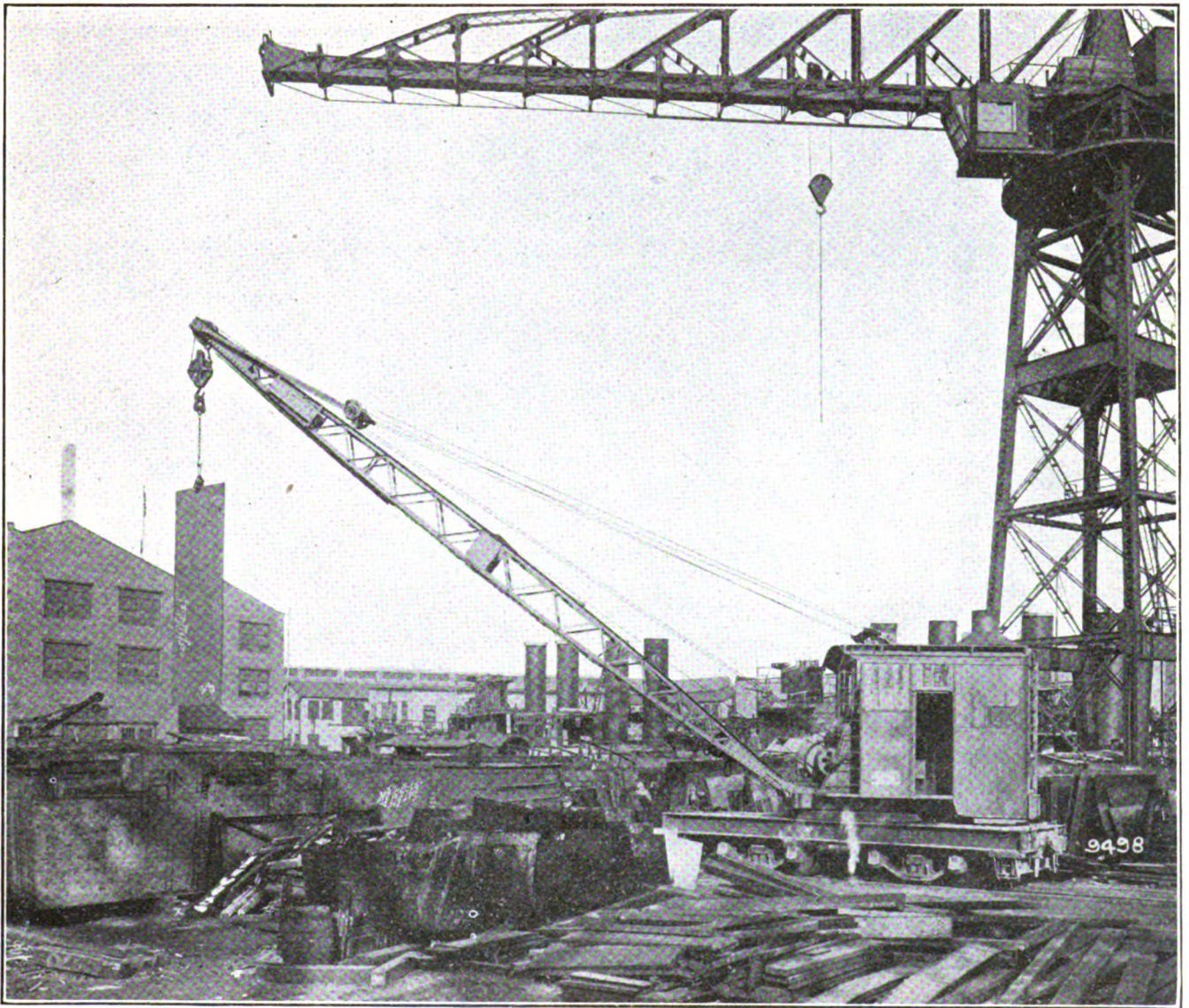
By RUSSELL BYRON WILLIAMS

IN 1790 there were approximately 2,810,000 people in the newly formed United States. Not quite as many as are now in the city of Chicago. Of that 1790 population, 83 per cent, or 2,345,000 were English. Of the remaining 17 per cent, 6 per cent were Scotch, 5 per cent German, 2 per cent Dutch, 1½ per cent Irish. The small 2½ per cent still unaccounted for was comprised of 13,384 French, 1,243 Hebrew, a few Scandinavian and others.

This, then, is the combination that produced America. That was the original scant 3,000,000 that

wrote the Declaration of Independence, fought for it, established it, worked it. And what they established and worked has remained established and has been working ever since—with a measure of success unparalleled by any race or government.

It has been said by many, both well and ill-intentioned, that the only true "American" was the Indian; that in reality there was no such thing as an "American." This is erroneous. The true American is of the same blood as his forefathers. He is 83 per cent English, 6 per cent Scotch, 5 per cent German, 2 per



Handling plates at Navy Yard.

Handling heavy materials by crane, either locomotive or crawler, is one way in which we can keep America for Americans. It is estimated that this crane replaces from 25 to 50 men. Photo taken at Cramps Shipyards, Philadelphia, Pa.

cent Dutch—with a few Irish, French, Hebrew and miscellaneous freckles. In short, the true American is he who speaks the English language as his ancestral tongue—he who loves and reverences the great charters of liberty (Magna Charta, Declaration of Independence, etc.) and he who finds his greatest in-

The situation in Europe, proposed legislation, prohibition, labor conditions, the soldiers' bonus, the coming November elections—all are questions of importance. All have their bearing upon the welfare of this country. There is nothing so important to us, however, as the character of the future American. This article treats on this subject, pointing out ways wherein every manufacturer can do his part toward the betterment of future America. We commend it to your attention.

spiration in the literature written in English and in the King James version of the Bible.

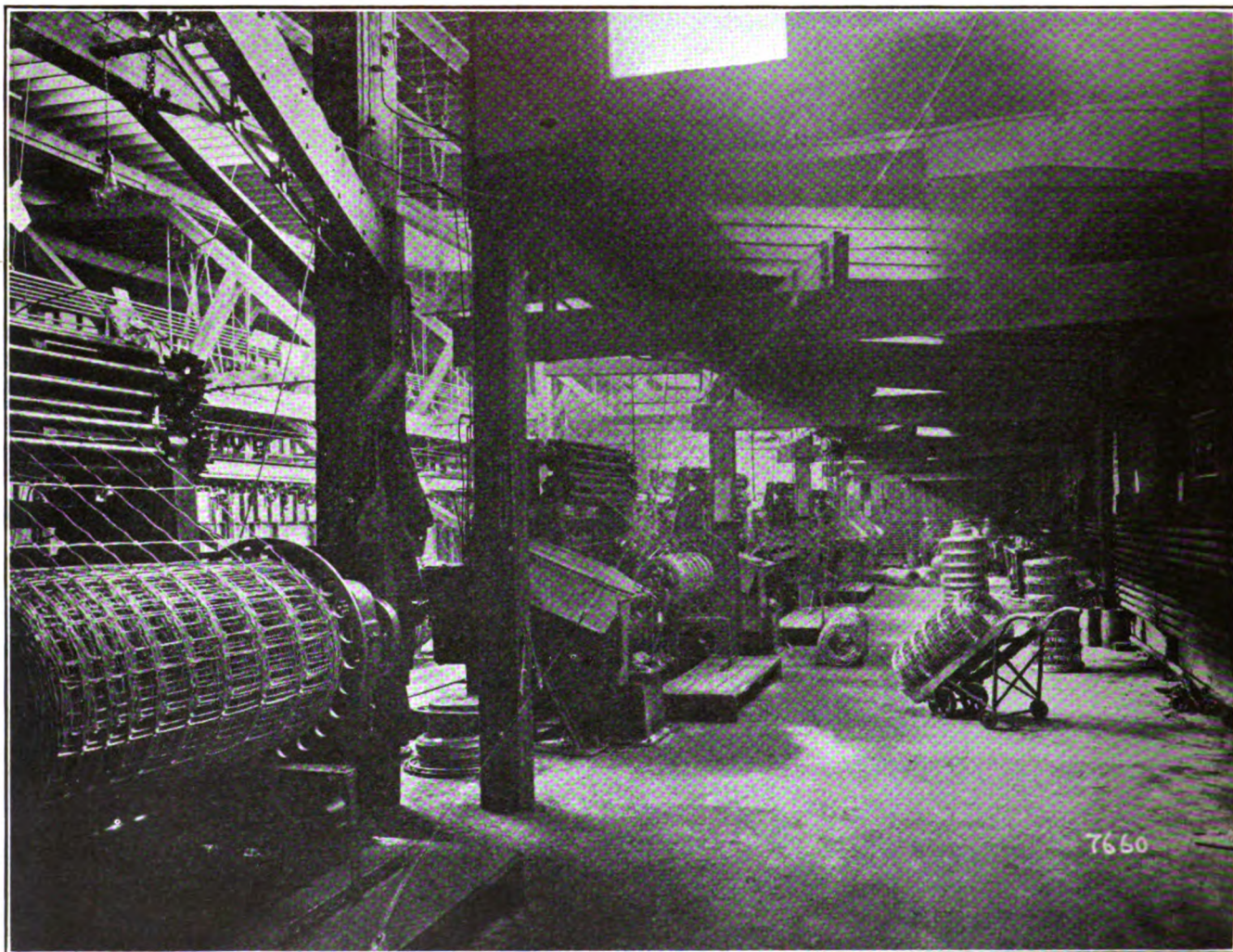
Such is the true American and such he has been since the establishment of the American government. He has always been a distinct type, and, thus far, has

been dominant in the progress of the American nation. Pray God, may he always be.

However, it is high time that we look to our future—to make sure that we can thoroughly assimilate all those who enter our gates. For—there are distinct and sinister signs of retrogression. We Americans no longer form 83 per cent of the nation's population. We are a scant 55 per cent. Instead of 1,243 Jews on American soil, as in 1790, there are 1,643,000 Jews in New York City alone. That means that while the country has been growing from a scant 3,000,000 to an approximate 110,000,000—37 times its own size—one alien race has multiplied itself over 1,000 times in one city alone.

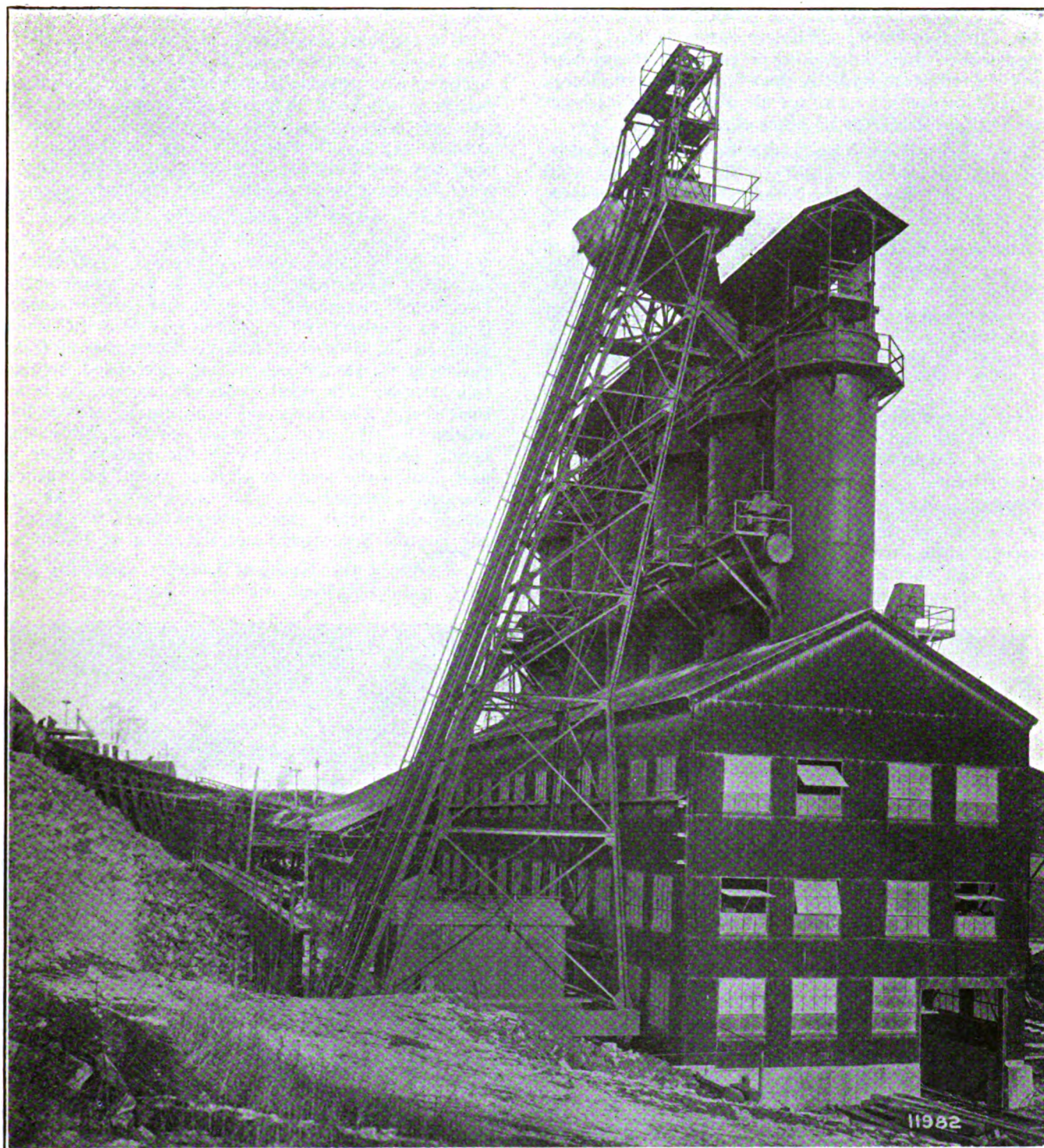
In the same strain, out of our population of 110,000,000 we now have 14,000,000 of foreign born, and 23,000,000 of foreign or half-foreign parentage. All told, in the brief period of 103 years (1820) there have been admitted to this country 34,000,000 aliens—and they speak 30 different languages.

Have we, as Americans, assimilated them—or have they remained unassimilated and un-Americanized? Are they clots of foreign matter on the surface of a deep and tranquil and harmonious sea of Anglo-Saxon? Are they as floating buoys that tend to break up the waves of American progress?



View of mill room at Cayuga Steel Company, Ltd., Auburn, N. Y. -

Battery of woven wire machines driven by individual motors and silent chain. Note extreme freedom and absence of light obstruction. Production has been increased through elimination of slippage, journal friction, etc., which is tantamount to a reduction in payroll.



Traveling skip hoist—capable of delivering to any one of six kilns. Supported on 4 wheels it is 34-in. square at base and 100 feet high. Each skip holds 3 tons. Capacity 100 tons the hour.

If they have been assimilated—if they have become “Americanized”—why do these 34,000,000 maintain over 900 publications issued in their own individual language, ranging alphabetically from Albanian and Arabic to Yiddish? If they are Americans, how does it come that some foreign boys of 8 or 10 are punished severely when they, in a burst of childish enthusiasm and all unmindful of previous admonitions, run into their homes speaking the English language? Why is it (or was, as I have not been there since 1918) that German is taught in the public schools of certain parts of North Dakota and

Nebraska instead of English? Why, in Passaic, N. J., are 4 of every 10 women foreign born and 60 per cent of that female element bread winners? That in itself would not be so bad if it were not true that 45 per cent of those female workers cannot read, write or speak English. This, in spite of the fact that two-thirds of them have been here 10 years or more, with only 73 of the 7,500 found to be recent immigrants. Why should the literature of a certain religious denomination in Chicago describe one of its institutions as an organization where members are expected to be “guardians of everything that is divine” and “foreign”,

in order to grow up to be real patriots and defenders of the Christian faith? Why, in Newark, N. J., only 29 per cent of the school children possess fathers born in the United States? Why does New Bedford, Mass., find itself compelled to admit an illiteracy of 12.1 per cent of all persons over 10 years of age?

This sort of question could be asked endlessly, each question adding weight to the conviction that they have not been assimilated, and what is worse, they have little or no desire to become so.

Aliens of eastern and southern Europe, or of Asiatic extraction, find it exceedingly difficult to accept the views and doctrines of our country and life. In religious, social and governmental instincts they are as widely divergent as the poles. Steeped in hundreds and thousands of years of viewpoints, ideals and aims diametrically opposed to ours, it is well nigh impossible to Americanize these people short of several generations. In our "melting pot" they are slugs of slate and bone—things apart. Inefficient as workmen and unassimilable as citizens, we want no more of them.

But however disturbing this element, it is apparent we cannot deport them. We can, and should, however, stop their brothers and neighbors from entering our doors. We can place greater restriction upon our immigration laws "But—hold on!" shouts

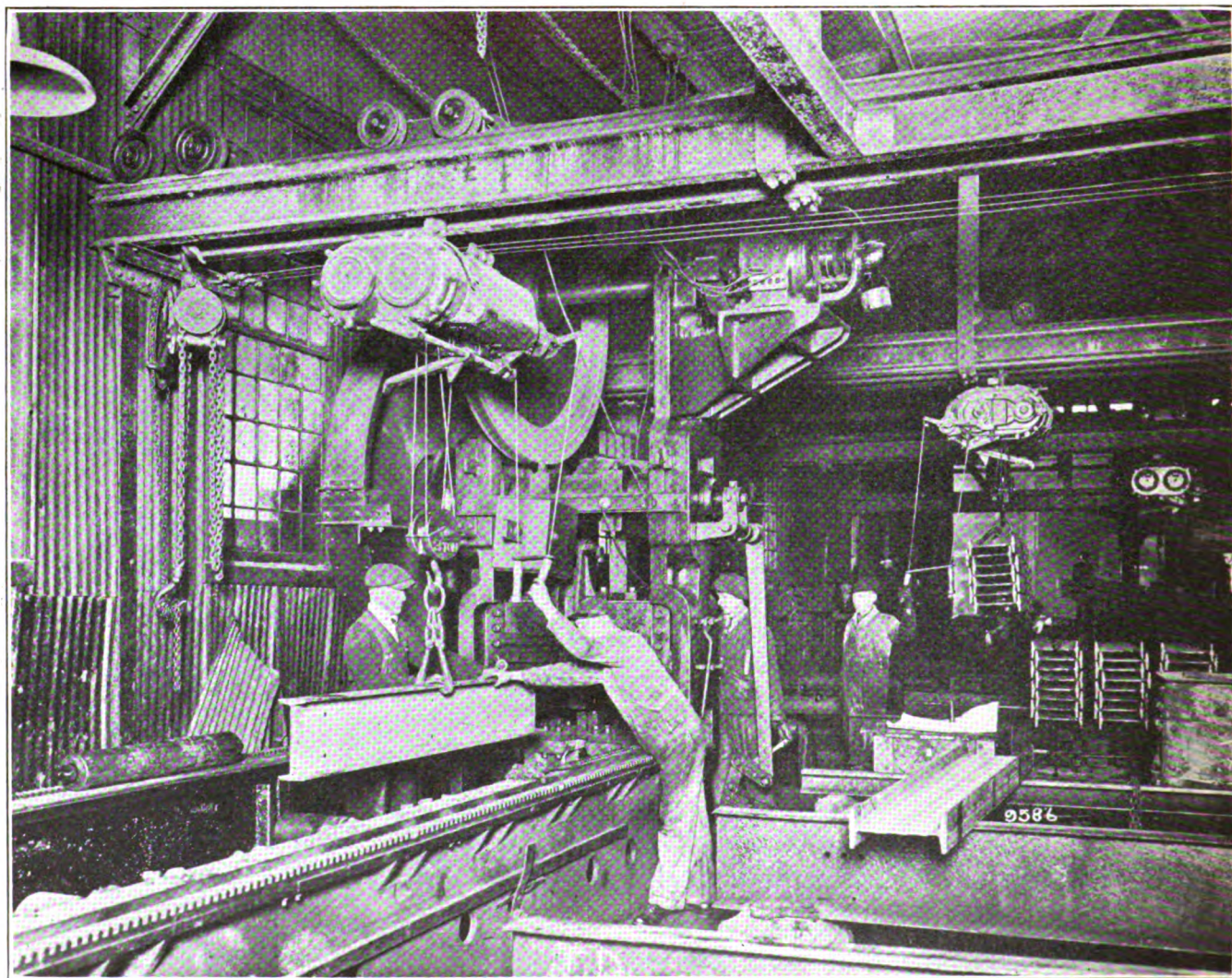
the large employer. "What about our labor supply?"

To that we answer—give machines to the man you have. The foreigner now here can, after a time, become Americanized—providing his foreign mentality is not kept alive with overseas ideas and the process retarded by fresh arrivals from his homeland. And he can handle machines. As for the machines—they are not radical—they do not strike—they are already Americanized—they are far more efficient.

And to prove the justifiability of machines:

Mr. Sherman, general manager of the Detroit Vapor Stove Company, employs two 1,000 conveyors on which their "Red Star" stoves are now completely assembled, enameled, dried, crated, carried from one floor to another, and deposited either on the shipping platform or in the warehouse. With this method the stoves come to the men, each specialized in his particular task. The result is steady production, less confusion and absolutely no handling of stoves by the workmen. He says: "Were we to employ the old bench assembly, fully twice the factory floor space and double the number of men would be required to assemble, enamel and crate our stoves." Taking this statement literally, his conveyor saves 50 per cent of the factory floor space and the labor of 100 men.

Formerly the National Lumber Company of Chicago unloaded their incoming cars of lumber by



Electric Hoists replacing common labor in the handling of heavy I-beams at plant of Phoenix Iron Company, Phoenixville, Pa.

hand. Under this method it required the time of three men 12 hours to complete the handling of one car. Now they employ a crawler type of crane with the result that the time element is reduced from 12 hours to 3½ hours—a reduction of nearly 75 per cent.

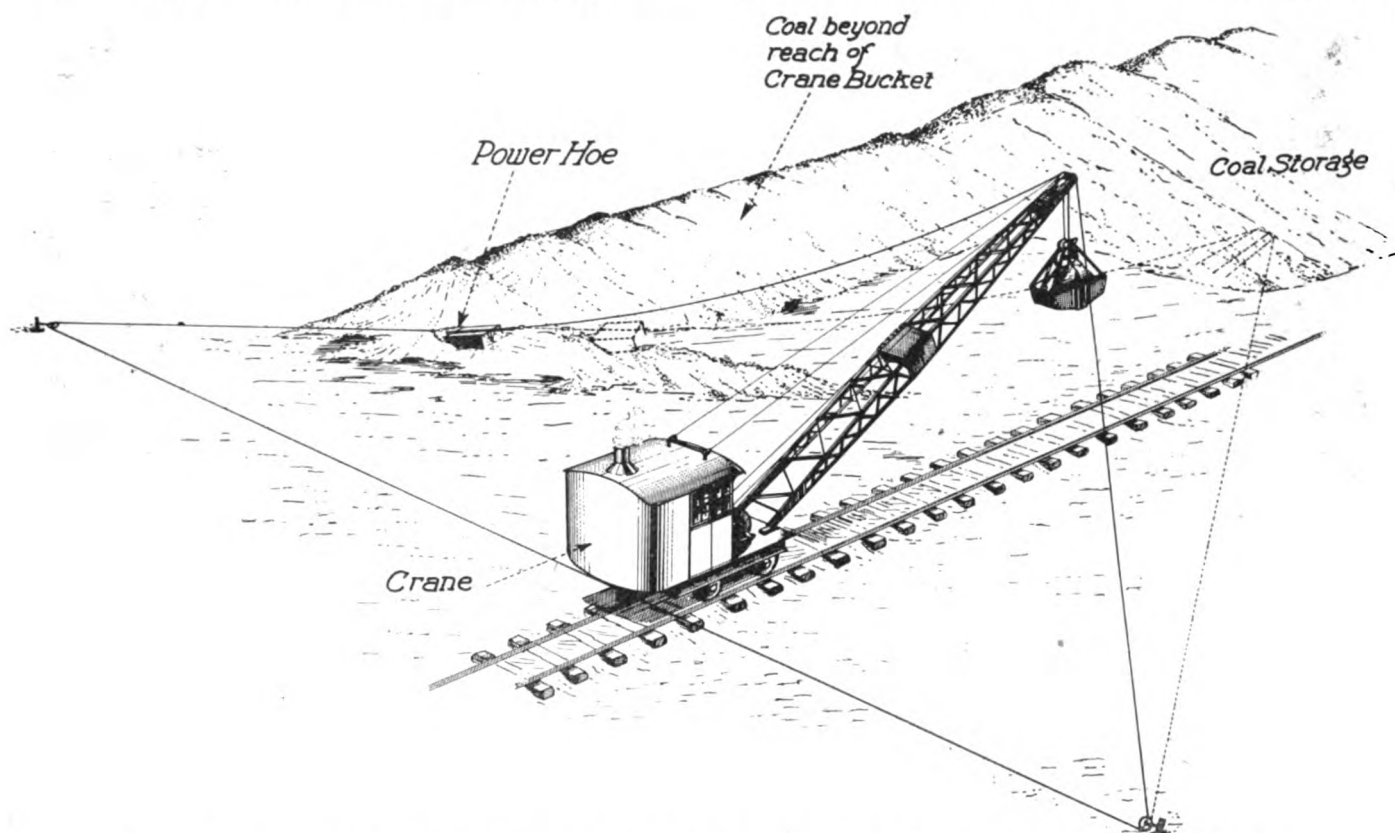
For a long time the Fisheries Products Company of Norfolk, Va., handled their fertilizer with picks and shovels and push carts. But they found this method too slow—too expensive. So they bought a mechanical loader. Result: This loader does as much work as was formerly accomplished by eight men. Saving the labor of eight men a day (at 32½ cents an hour) totals over \$6,000 annually. Not alone are mechanical means an end to overcoming labor shortage or the elimination of the undesirable alien, but also a medium for the extension of profit.

At the Superior Sand & Gravel Company, Detroit, a fleet of 30 five and six-ton trucks are employed for

was particularly difficult because of the necessity for non-interference with the daily progress of the newspaper plant. Steam shovels or cranes were out of the question as the upper part of the building could not be removed and only a small portion of the floor torn away.

In order that this unusual condition might be met satisfactorily an electric hoist was pressed into service. This hoist lifted large buckets of dirt and refuse to awaiting trucks. The capacity of the hoist was about 14 trucks a day.

Were it not possible to thus employ a hoist it would have been necessary to remove all of this dirt and debris by hand. And this would necessitate the construction of two shovel platforms, each platform having three men with shovels. Not only would this have slowed up the work, but the construction of the platforms would have made necessary the demolition



Storing and reclaiming coal beyond the reach of the crane boom through the use of the power hoe attachment.

delivering sand and gravel. Formerly they maintained a gang of 100 men—just to load these trucks. Under this method it required from 10 to 15 minutes to load each truck. Now they have erected two hoppers, elevated 10 feet above the ground, each hopper holding 150 tons of material. To fill these hoppers a locomotive crane is used—a task that is completed in less than an hour. The motor trucks now draw up under the hopper and are loaded in 1½ minutes—and are off on the job of delivering the material. The installation of the hoppers and locomotive crane has released 100 men for other and perhaps more fruitful labor.

At the publishing plant of the Boston American, Adams & Pond, general contractors, were employed in the excavation work that made possible the installation of additional presses in the basement of their old building. Lowering the level of this basement

of the sidewalk with consequent replacement at the time the work was completed. Thus the hoist saved the labor of six men a day together with the labor and cost of demolishing and reconstructing a section of cement sidewalk.

Formerly the Milwaukee Bridge Company employed painters in the erection of their bridges and steel structures. Now, almost universally, they use one operator equipped with a paint spray gun, which equipment eliminates from five to six men with 4-inch brushes.

And speaking of economies affected through the use of spray guns, Mr. Clark, general manager of the Hyde Park Hotel, Chicago, recently redecorated the lobby and two adjacent rooms of his hostelry. He used one operator and one spray gun and the time required to complete the work was 2½ hours. Formerly the work required eight painters 16 hours—



A very interesting development wherein gasoline tractor is combined to effect several combinations. A Clark Duat carrying steel casting on crane, while towing two trailers which were loaded by the crane.

and eight painters for 16 hours at \$1.25 an hour is quite a different matter.

One of the public service corporations serving the city of St. Louis consumes a large tonnage of coal. This coal was formerly handled by hand, with the result that one man unloaded an average of one car a day. Now they have installed a gondola car dumper, which dumper is little more than an immense cradle whose function is to turn, topsy-turvy, a standard sized gondola car of coal—dumping the contents into a hopper below. This cradle or dumper, operated with an unskilled laborer and a 45-hp. motor, dumps cars at the rate of 25 to 30 an hour.

The rotary car dumper was pictured and described in detail on pages 127-128 in February, 1924, Blast Furnace & Steel Plant.

These are but a few of the unnumbered instances wherein machines have performed double duty—that of yielding a profit for their employer as well as alleviating the need for cheap and undesirable labor. And, in the long run, there is little question which is the more valuable of the two.

The necessity for making money is obvious. The Ruhr, prohibition, coal tax and other questions are important to the welfare of this country. But no question is so important as that of the character of the future Americans. And whether they be a credit or a discredit can be determined by us—now. Bar the undesirable. Provide ourselves with machines. Keep America for Americans.

Power Company to Install New Equipment

The Columbia Power Company, a subsidiary of the Columbia Gas & Electric Company, has contracted with the Fuller-Lehigh Company for complete pulverized coal preparation, conveying and burning equipment for eight 1500-hp. Babcock & Wilcox boilers to be installed at the new Miami Fort Power Station.

Pulverized coal was chosen as the fuel after the Columbia Power Company engineers, in conjunction with their consulting and designing engineers, Sargent & Lundy Company of Chicago, had made extensive investigations and tests as to the economies involved by the use of pulverized coal.

The equipment will comprise six 57-in. Fuller-Lehigh screen type pulverizers, gear driven. Two 6 ft. 6 in. by 50 ft. Fuller-Kinyon pumps will convey the coal from pulverizers to weigh bins, and 10-in. pumps will distribute the fuel from the weigh bins to the boiler bins. Each boiler will be equipped with five Fuller Triplex Feeders, driven by variable speed motors. The boilers will be of hollow wall design with no water screens; equipped with economizers and air heaters. Operating pressure of the station will be 575 lbs; total steam temperature approximately 725 deg. F.

Generating equipment for the first unit will be two 40,000-kw. reheater turbines. Furnaces will be designed for average rating of 225 per cent with peaks of 350 per cent.

Cahokia—A Masterpiece!

Newest Super-Power Plant Constitutes a Study in Material Handling—Unusual Opportunity Here Afforded to Analyze the Problems Involved

By F. J. CROLIUS

IN a recent publication entitled, "St. Louis, the Coming Steel, Iron and Metal Center, and Why," issued by the Mercantile Trust Company, President F. J. Wade enumerates many advantages, stated briefly as follows:

- 1—Center of nation and center of great producing and consuming area.
- 2—Low freight rates and unsurpassed shipping facilities.
- 4—Cheap and abundant coal at door.
- 5—Cheap and abundant electric power.
- 6—Development of Mississippi River and in-

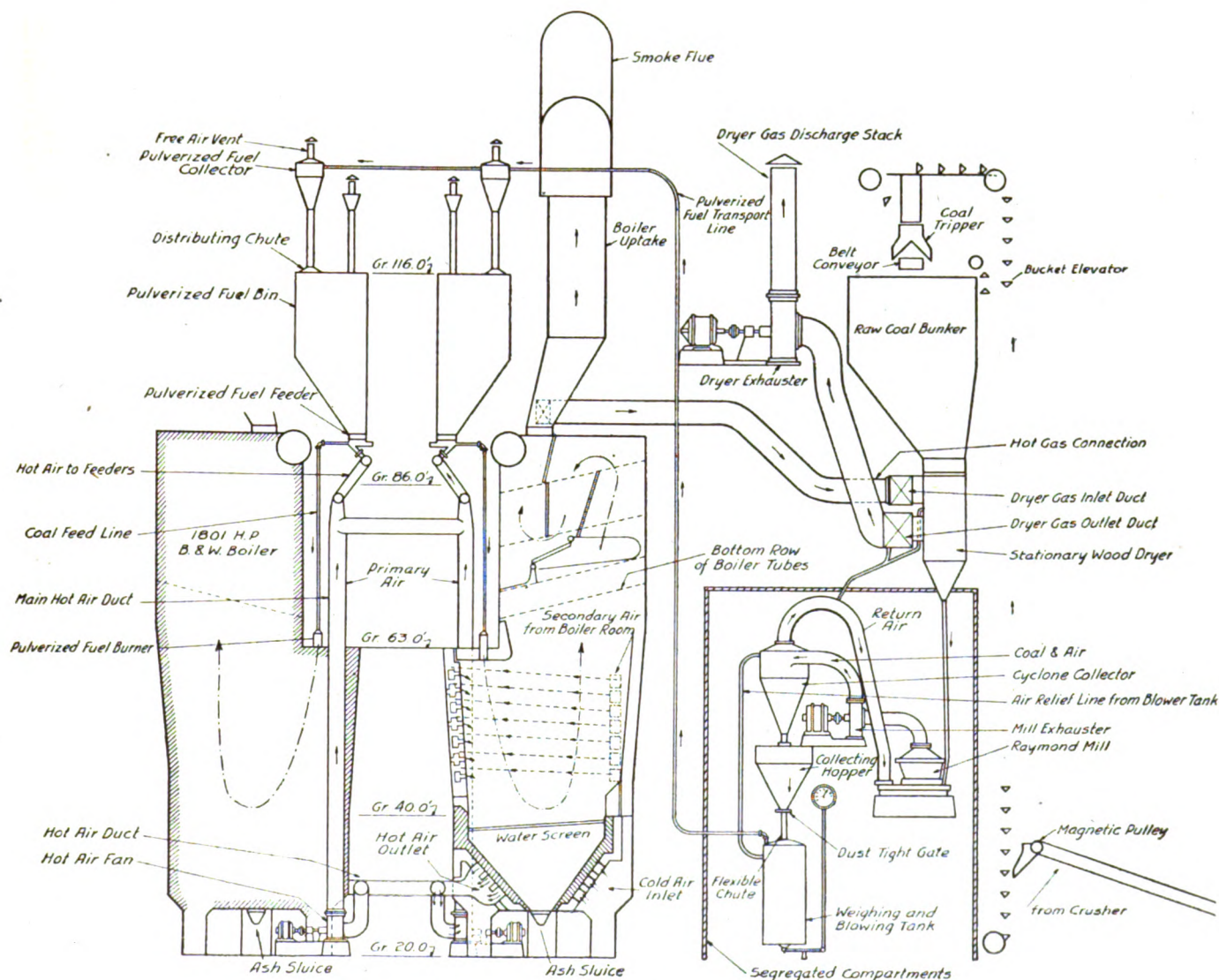
land waterways, providing cheap water carriage and insuring low railroad rates.

Among these advantages, Cahokia, the new \$35,000,000 electric plant, stands out prominently.

"Muscle Shoals is big. When completed, Cahokia will have three times the year round power of Muscle Shoals. Cahokia will use a ton of coal every 30 seconds, and 616,000,000 gallons of water per day."

Very few have a very comprehensive idea of the elements involved in such a power development.

Through the courtesy of McClellan & Junkersfeld, the engineers and constructors, we are privileged to detail this remarkable assembly of modern devices for material handling interpreted in terms of power.



Cross-section of Cahokia showing the steam generating and coal preparation units.

Principal Equipment in the Cahokia Station

GENERAL

PLANT LOCATION—East bank of the Mississippi River, near East St. Louis, Ill.
CHARACTER OF LOAD—Domestic and industrial load of the City of St. Louis, Mo., East St. Louis, Ill., and surrounding territory.
PRESENT CAPACITY—60,000 kw.
UNDER CONSTRUCTION—65,000 kw.
ULTIMATE CAPACITY—300,000 kw.
ENGINEERS AND CONSTRUCTORS—McClellan & Junkersfeld, Inc., of New York.

MECHANICAL EQUIPMENT

RAW COAL HANDLING EQUIPMENT—

Weighing—1 Buffalo Scale Co. track scale.
 Unloading—1 Link Belt Co. 90-ton gondola rotary car dumper; 1 Auxiliary open track hopper.
 Conveying—Link Belt Co. apron conveyors, belt conveyors and elevators. Capacity 300 tons per hour.
 Belting—6-ply rubber belting by U. S. Rubber Co.
 Crushing—1 Bradford coal breaker (primary); capacity 350 to 400 tons per hour. 1 American Pulverizer Co. swing ring crusher (secondary for rejects from Bradford breaker); capacity 50 to 60 tons per hour.
 Magnetic Separators—2 24x38-in. Ding magnetic separators.
 Crushed Coal Storage—Concrete bunkers; capacity 1,600 tons.
 Storing and Reclaiming—1 Brownhoist locomotive crane. 1 American Hoist & Derrick Co. locomotive crane. 1 American saddle tank locomotive.

PULVERIZED COAL HANDLING EQUIPMENT—

Weighing and Transport—5 Howe Scale Co. platform scales; capacity 4.5 tons. 1 Quigley compressed air coal transport system; capacity 94 tons per hour.
 Storage—Concrete bins; capacity 500 tons.

DRYING, PULVERIZING AND COMBUSTION EQUIPMENT

METHOD OF FIRING—Pulverized coal, Lopulco system.

MAKE AND TYPE OF COMBUSTION EQUIPMENT—Combustion Engineering Corporation.

Drying—10 Wood coal dryers manufactured by the Combustion Engineering Corporation; flue gases utilized as drying medium; capacity 6.5 tons per hour from 12 to 5 per cent moisture.
 Induced Draft for Dryers—2 60,000 CFM fans by B. F. Sturtevant Co., driven by 125-hp., 425-rpm., 2300-volt, 60-cycle, 3-phase, squirrel cage induction motors.
 Pulverizing—8 Raymond Bros. Impact Pulverizer Co. 6-roll pulverizers; capacity 6 tons per hour each. Drive—Direct connected 100-hp., 450-rpm., 2300-volt, 60-cycle, 3-phase, squirrel cage induction motors.
 1 Raymond Bros. Impact Pulverizer Co. pulverizer; capacity 15 tons per hour. Drive—200-hp. belted motor.
 Lopulco feeders and burners.

Number of Feeders—10 feeders per boiler.

Method of Drive—10 feeders on each boiler driven by a 15-hp. variable speed d.c. motor.

PRIMARY AIR FANS—4 20,000 cfm., 15 in. S. P. B. F. Sturtevant Co. blowers.

METHOD OF DRIVE—100-hp., 1200-rpm., 2300-volt, 60-cycle, 3-phase squirrel cage induction motors.

COMBUSTION CONTROL EQUIPMENT (2 boilers) furnished by Bailey Meter Co.

BOILER UPTAKES AND FLUES by Connery & Company. Steel plate, gunite lined.

Furnaces

TYPE—Air cooled side walls and ash hopper, water screen cooled rear wall and bottom.

REFRATORIES—Fire brick by Laclede Christy Clay Products Co. and Evans & Howard Fire Brick Co. Refractory tile by Walsh Fire Clay Products Co.

INSULATING BRICK—Sil-o-Cel C-22 by Celite Products Co.

FURNACE CASING—Sheet steel.

SUSPENDED ARCHES—4 by M. H. Dietrick Co. 4 by Liptak Fire Brick Arch Co.

FURNACE VOLUME—11,440 cu. ft. per boiler.

BRICKWORK erected by D. Seeger.

ASH GATES—Number—2 per boiler. Manufacturers—Allen-Sherman-Hoff Co.

ASH HANDLING EQUIPMENT—Hydraulic sluicing system from ash hoppers to sump. Make—Allen-Sherman-Hoff Co.

2 dredge pumps for removing ashes from sump. Make—Morris Machine Works. Size and type—6-in. centrifugal, manganese steel lined. Drive—Direct connected 75-hp., 1200-rpm., 2300-volt, 60-cycle, 3-phase, squirrel cage induction motors.

Stacks—Type—Tile-concrete. Make—Wiederholdt Construction Co. Inside diameter at top, 19 ft. Height above burners 325 ft. Supported on building steel.

WATER SUPPLY

SOURCE AND CHARACTER OF RAW WATER—Mississippi River water containing scale forming salts.

PRIMARY TREATMENT—Calcium hydrate and iron sulphate.

Manufacturers of Equipment—Graver Corporation.

Type of Equipment—Cold Process.

Capacity of Equipment—600 gpm.

Used For—Cooling bearings and service water.

SECONDARY TREATMENT—Barium hydrate.

Manufacturers of Equipment—Graver Corporation.

Type of Equipment—Cold process.

Capacity of Equipment—600 gpm.

Used For—Evaporator raw water and emergency make up to boilers.

Chemicals handled and weighed by traveling weigh larry furnished by Strait Scale Co.

Drinking Water

SOURCE—Water after primary treatment described above.

TREATMENT—Filtered, chlorinated and cooled.

CAPACITY—20 gpm. at 50 deg. F.

REFRIGERATION SYSTEM by R. H. Tart & Sons, Inc.

TYPE—Ammonia.

FILTERS by The New York Continental Jewell Filtration Co.

TYPE—Sand and bone black.

BOILER FEED WATER MAKE UP—

Source—Evaporators.

Manufacturers of Equipment—Sugar Apparatus Mfg. Co. (Lillie.)

Type of Equipment—Low pressure, two effect, condensate as cooling water through the evaporator condenser.

Capacity—10,000 lbs. per hour.

DEAERATING EQUIPMENT—

Manufacturers of Equipment—H. S. B. W. Cochrane Corporation.

Type of Equipment—Open heater, reboiler type.

Capacity of Equipment—720,000 lbs. per hour.

Source of Steam—Exhaust from house turbines.

BOILER FEED PUMPS AND EXCESS PRESSURE REGULATORS

4—4-in. Allis Chalmers Mfg. Co. 6 stage, 750 gpm., 1760 rpm., 425 lbs. per sq. in.

3 driven by 300-hp., 1760-rpm., 2300-volt, 60-cycle, 3-phase General Electric Company slip ring induction motors.

1 driven by 300-hp., 1760-rpm., Terry steam turbine exhausting to deaerating heater.

3—Ruggles Klingemann excess pressure regulators for varying speed of motor driven feed pump motors.

1—Fischer Governor Co. excess pressure regulator for varying speed of turbine driven boiler feed pump.

Closed Feed Water Heaters—2 Alberger Pump & Condenser Co. closed Wainwright floating head feed water heaters using bled steam from main turbines.

Oil and water tanks by Hamler Boiler & Tank Co.

BOILERS AND SUPERHEATERS

BOILERS, MAKE AND TYPE—Babcock & Wilcox; horizontal cross drum, sectional; water tube.

NUMBER—Present 8.

RATING AND TUBING—1801 hp., 18,010 sq. ft., 38 tubes wide, 20 tubes deep, 4-in. tubes; 20' 0" long boiler drum = 60" D. x 33' 6" long.

WATER SCREEN—Bottom and rear of furnace. 4" tubes 580 sq. ft. effective surface.

SUPERHEATERS—Babcock & Wilcox Alert type located above sixth row of boiler tubes.

SURFACE AND TUBING—4,070 sq. ft. per boiler. 2" tubes No. 10 gage.

SOOT BLOWERS—

Type—Diamond.

Number of Elements—18 per boiler.

BOILER FEED WATER REGULATORS—2 Copes regulators per boiler.

PIPING, VALVES AND COVERING

High pressure steam, boiler feed and boiler blow-off piping and fittings by Midwest Piping & Supply Co.

Low pressure steam piping and fittings by Steero Engineering Co.

Circulating water piping by Joubert & Goslin Machine & Foundry Co.

Low pressure piping bought in stock lengths and fabricated by McClellan & Junkersfeld, Inc.

Heat insulation by Philip Carey Co. High temperature and 85 per cent carbonate of magnesia.

Boiler non-return and high pressure steam globe valves by Edward Valve & Mfg. Co.

High pressure steam gate valves by Crane Co.

Motor operating mechanisms for high pressure steam gate valves by Payne Dean, Ltd.

High pressure boiler feed gate and check valves by Chapman Valve Mfg. Co.

High pressure boiler feed globe valves by Lunkenheimer Co.

Low pressure steam and water valves by Nelson Valve Co. and others.

Circulating water hydraulically operated gate valves by Kennedy Valve Mfg. Co.

Atmospheric relief valves by Atwood & Morrill.

Yarway seatless blow-off valves in series with Lunkenheimer gate valves.

High pressure steam joints are of the Sargol type 800-lb. hydraulic standard.

High pressure boiler feed and low pressure steam joints are of the Van Stone type.

Piping systems erected by McClellan & Junkersfeld, Inc.

PRIME MOVERS

MAKE, TYPE AND NUMBER INSTALLED—1 General Electric Co. Curtis 17-stage; 1 Westinghouse Electric & Mfg. Co. semi-double flow.

RATING—30,000 kw., 35,000 kva.; 30,000 kw., 35,000 kva.

ELECTRICAL CHARACTERISTICS—13,800 volt, 3 phase, 60 cycle; 13,800 volt, 3 phase, 60 cycle.

SPEED—1800 rpm.; 1800 rpm.

STEAM CONDITIONS AT THE THROTTLE—300 lbs. 690 deg. F.; 300 lbs. 690 deg. F.

VENTILATING AIR FOR GENERATOR—80,000 cfm. at 104 deg. F.; 84,000 cfm. at 104 deg. F.

HOUSE TURBINES

MAKE—Westinghouse Electric & Mfg. Co.

TYPE—Horizontal; non condensing.

NUMBER—Installed 2; Ultimate 2.

RATING—2000 kw., 2500 kva.

ELECTRICAL CHARACTERISTICS—2300 volt, 3 phase, 60 cycle.

SPEED—3600 rpm.

STEAM CONDITIONS AT THROTTLE—300 lbs. 690 deg. F.

STEAM CONDITIONS AT EXHAUST—18 lbs. absolute.

VENTILATING AIR FOR GENERATOR—8,000 cfm. at 104 deg. F.

LOAD CARRIED—Essential auxiliaries.

GENERATOR AIR COOLING SYSTEM

SYSTEM—Closed system with surface coolers.

AIR COOLERS—2 Griscom Russell Co. surface air coolers using condensate as cooling medium.

HEAT EXCHANGERS—For sub-cooling condensate: 2 Whitlock Coil Pipe Co. spiral flow heat exchangers using circulating water as cooling medium.

Generator air ducts by John Nooter Iron Works.

Type—Steel plate.

Generator fire suppression system.
PRIMARY—Receivers of CO₂ gas at 200 lbs. pressure discharging to closed ventilating system.
SECONDARY—Water coils in end bells of generators.

CONDENSERS

NUMBER, MAKE AND TYPE—2 Worthington Pump & Machine Corporation 53,000 sq. ft., 2 pass surface condensers.
TUBES: SIZE, MATERIAL, GAGE AND MAKE—1 in. O. D. Admiralty Metal No. 18 B. W. G. furnished for one condenser by Wheeler Condenser & Engineering Co., and for the other condenser by Scovill Mfg. Co.
CIRCULATING PUMPS (each condenser)—2 30-in. Worthington Pump & Mach. Corporation. 27,000 gpm. each in parallel; 33,000 gpm. each operating alone.
CIRCULATING PUMP DRIVE—Direct connected 250-hp., 2300-volt, 60-cycle, 3-phase, 385-rpm., General Electric Co. slip ring induction motors.
CONDENSATE PUMPS (each condenser)—2 6-in. Worthington Pump & Mach. Corporation 800-gpm., 225-ft. head, 2-stage.
CONDENSATE PUMP DRIVE—Direct connected, 75-hp., 2300-volt, 60-cycle, 3-phase, Wagner slip ring induction motors.
AIR REMOVAL EQUIPMENT (each condenser)—1 33x24 in. Laidlaw-Dunn-Gordon feather valve rotative dry vacuum pump.
R. D. V. PUMP DRIVE—50-hp., 440-volt, 60-cycle, 3-phase, 600-rpm., Wagner slip ring induction motor through silent chain drive at 100 rpm. max.

Sluice Gates

MANUFACTURER—Coffin Valve Co.
NUMBER—11 gates 1 butterfly valve.

INTAKE WATER SCREENS

PRIMARY—Bar racks below low water.
SECONDARY—4 5'0" wide 52'0" center to center sprockets Link Belt Co. traveling water screens.
DRIVE—5-hp., 1200-rpm. squirrel cage induction motors through Jones speed reducers.
ON RAW WATER PUMPS—1 12" Elliott Co. twin strainer.

AUXILIARY EQUIPMENT

TURBINE ROOM CRANE—1 Niles-Bement-Pond Co.
Type—Alternating current.
Span—55 ft. 7 in.
Main Hoist—110 tons at 5 ft. per minute.
Auxiliary Hoist—10 tons at 25 ft. per minute.
Main Hoist Motor—60 hp., 600/300 rpm.
Auxiliary Hoist Motor—30 hp., 600/300 rpm.
Bridge Travel Motor—60 hp., 600/300 rpm.
Trolley Travel Motor—30 hp., 600/300 rpm.

AIR COMPRESSORS

NUMBER, MAKE, SIZE AND TYPE—2 Sullivan Machinery Co. 20x12x14-in., 760-cfm., 100-lb. angle compound compressors.
DRIVE—Belt driven by 2 Wagner 150-hp., 2300-volt, 60-cycle, 3-phase, 720-rpm., squirrel cage induction motors.
After coolers for air compressor by Whitlock Coil Pipe Co.
Auxiliary exciter.
1 300-kw., 250-volt, d.c., 1760-rpm. generator driven by a direct connected General Electric Co. steam turbine and a General Electric Co. squirrel cage induction motor.

SPECIAL CENTRIFUGAL PUMPS

PUMPS FOR RAW, SEMI-TREATED AND TREATED WATER—5 6-in. Worthington Pump & Mach. Corp. 2-stage, 500-gpm., 200-ft. head, driven by Wagner 50-hp., 440-volt, 60-cycle, 3-phase, 1200-rpm., squirrel cage induction motors.
SLUDGE PUMPS—2 4-in. Worthington Pump & Mach. Corp. single stage, 350-gpm., 75-ft. head, driven by Wagner 15-hp., 440-volt, 60-cycle, 3-phase, 1800-rpm. squirrel cage induction motors.
MAKE-UP PUMPS—2 4-in. Worthington Pump & Mach. Corp. single stage, 500-gpm., 65-ft. head, driven by Wagner 20-hp., 440-volt, 60-cycle, 3-phase, 1200-rpm. squirrel cage induction motors.
SUMP PUMPS—3 Yeomans Bros. single stage, 500 gpm., 75-ft. head submerged sump pumps, driven by Wagner 20-hp., 440-volt, 60-cycle, 3-phase, 1200-rpm. squirrel cage induction motors.
FIRE PUMP—1 6-in. Dayton Dowd two-stage, 750-gpm., 200-ft. head, driven by Wagner 75-hp., 2300-volt, 60-cycle, 3-phase, squirrel cage induction motor.
HEATING SYSTEM RETURNS—2 Nash Engineering Co. 16,000 sq. ft. heating system return and vacuum pumps driven by 2-hp., 1800-rpm., 440-volt, 60-cycle, 3-phase squirrel cage induction motors.
TRANSFORMER OIL CIRCULATING PUMPS—7 2-in. Worthington Pump & Mach. Corp. two-stage, 110-gpm., 80-ft. centrifugal oil pumps, driven by 5-hp., 440-volt, 60-cycle, 3-phase, 1200-rpm. squirrel cage induction motors.
Priming Vacuum Pumps—2 No. 1 Hytor pumps by Nash Engineering Co.
Drive—Direct connected 7½-hp., 900-rpm., 440-volt, 60-cycle, 3-phase squirrel cage induction motors.

Test Tanks

TANKS by Hamler Boiler & Tank Co.
SCALES by Strait Scale Co.
CAPACITY—30,000 lbs. each.
NUMBER—2.

OIL PURIFYING SYSTEM

SYSTEM—Batch system for prime movers. Batch and continuous for main transformers.
PURIFIERS—2 No. 600 motor driven DeLaval centrifugal oil purifiers. Capacity—300 gph.
PUMPS—Circulating and filling; American Steam Pump Co. back geared reciprocating pumps.

TRANSFORMER OIL COOLERS

SYSTEM—Forced oil circulation with external coolers.
COOLERS—7 Whitlock Coil Pipe Co. multiwhirl oil coolers using condensate as cooling medium.

LUBRICATING OIL COOLERS FOR PRIME MOVERS—

General Electric Co. Unit—Oil cooler by Andale Engineering Co. Cooling Medium—Condensate.
 Westinghouse Electric & Mfg. Co. Units (Main and House)—Griscom Russell Co. multiwhirl coolers. Cooling Medium—Main unit, condensate; house turbine, partially treated water.

VENTILATING FANS

1—7200-cfm., 470-rpm., American Blower Co. ventilating blower, driven by 5-hp., 1200-rpm., 440-volt, 60-cycle, 3-phase, squirrel cage induction motor through silent chain drive.
 2—1800-cfm., American Blower Co. propeller type blowers, driven by direct connected squirrel cage induction motors.

VACUUM CLEANING SYSTEM

MANUFACTURERS—Allen & Billmeyer Co.
CAPACITY—2 sweepers.

INSTRUMENTS

Wilson Maule Co. resistance thermometers, indicating and recording.
 Foxboro Co. recording thermometers and pressure gages.
 General Electric Co. steam flow meters with temperature and pressure records on same chart.
 Simplex Valve & Meter Co. recording flow meters for boiler feed water.
 Bailey Meter Co. boiler meters for recording steam flow, gas flow and flue gas temperature on each boiler.
Indicating Pressure and Vacuum Gages—
 Crosby Steam Gage & Valve Co.
 Ashton Valve Co.
 Schaeffer & Budenberg Mfg. Co.
 C. J. Tagliabue Mfg. Co.
 Manning, Maxwell & Moore, Inc. (Ashcroft).
Indicating dial thermometers by C. J. Tagliabue Mfg. Co.
Mercurial industrial thermometers by Taylor Instrument Co.

ELEVATORS

MANUFACTURERS—Otis Elevator Company.
 No. 1—Electrical bay; passenger and freight; 2500 lbs. at 75 ft. per minute. Full automatic dual control.
 No. 2—Boiler house; passenger and freight; 2500 lbs. at 150 ft. per minute. Full automatic with micro-leveling device dial control.
 No. 3—Coal elevator tower; passenger; 1000 lbs. at 137 ft. per minute. Full automatic; dual control.

IMPORTANT RATIOS

Cubic ft. of building to installed kw. (present).....	57.3 to 1
Cubic ft. of building to installed kw. (ultimate).....	43.3 to 1
Boiler heating surface to installed kw.....	2.4 to 1
Furnace volume to installed kw.....	1.5 to 1
Furnace volume to boiler surface (including water screens).....	0.615 to 1
Condensing surface to installed kw.....	1.75 to 1
Gpm. of circulating water to installed kw.....	1.80 to 1
Installed kw. to boiler feed pump capacity in gpm.....	20 to 1

ELECTRICAL EQUIPMENT IN THE CAHOKIA STATION

STATION TIE FEEDERS—Three 12,000-kva., 60-cycle, 3-phase, 33,000 volt.
OUTGOING FEEDERS—Eight 5000-kva., 60-cycle, 3-phase, 13,800-volt, and three 7500-kva., 60-cycle, 3-phase, 33,000-volt.
STATION TRANSFORMER FEEDERS—Two 3,000-kva., 60-cycle, 3-phase, 13,800-volt.
ELECTRICAL CONSTRUCTION, including installation of main oil circuit breakers, disconnecting switches, instrument transformers, high tension switchboards, d.c. control boards, etc., by McClellan & Junkersfeld, Inc.

MAIN OIL CIRCUIT BREAKERS

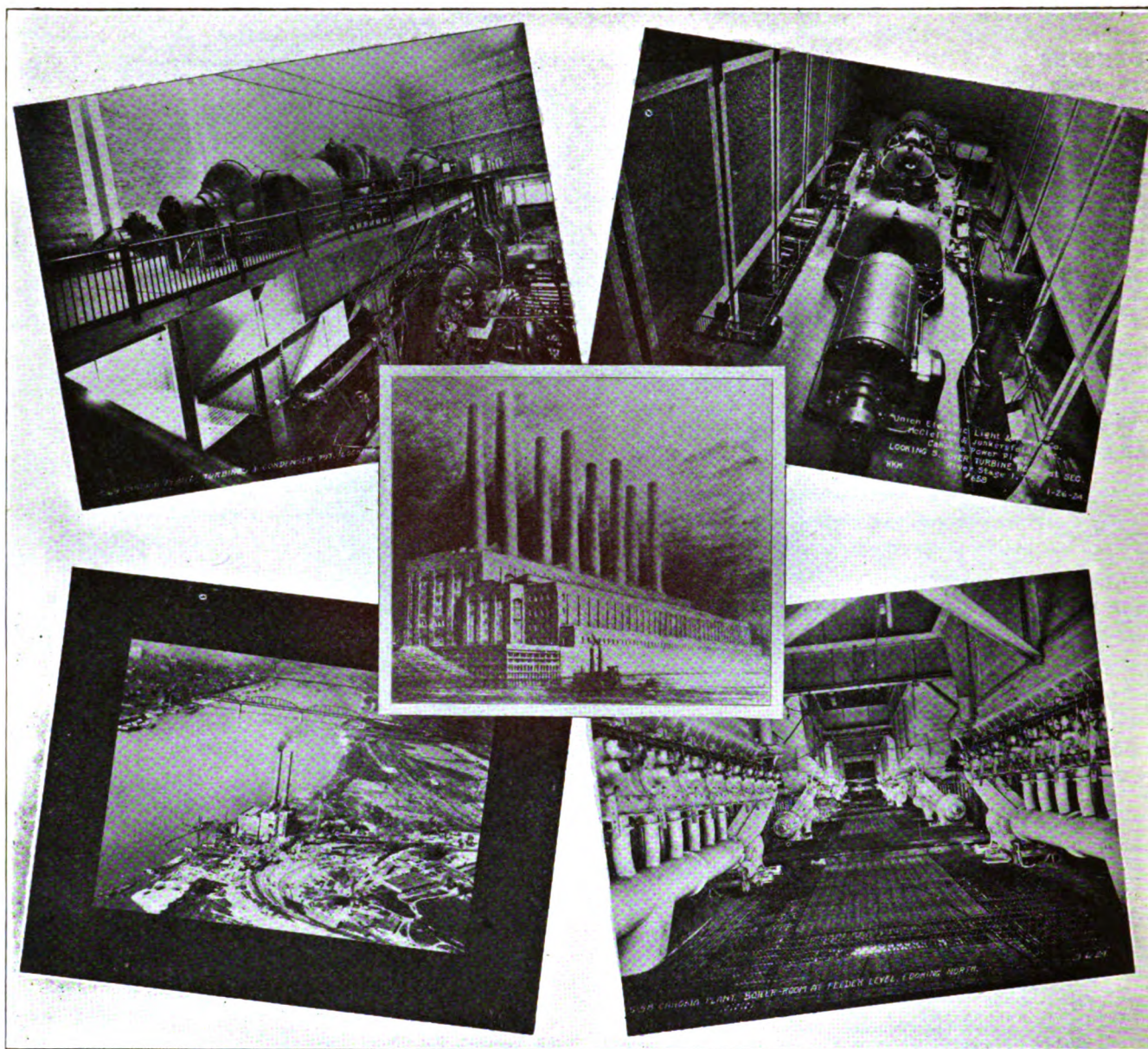
NUMBER INSTALLED—Six 2000-amp. for generators and bus ties; four 1200-amp. for generator neutrals, and 34 800-amp. for feeder bus selectors.
MAKE—General Electric Co.
TYPE—F. H. D. 17 single pole for isolated phase arrangement.
OPERATION—Remote controlled, motor operated at 125 volts d.c.
RUPTURING CAPACITY—38,000 amp. at 13,800 volts.
MOUNTING—Concrete compartments with separate floor for each phase. Vertical isolated arrangement with operating mechanism floor below circuit breaker floors.

2300 VOLT AUXILIARY POWER OIL CIRCUIT BREAKERS

NUMBER INSTALLED—Five 1200-amp. for auxiliary generators, station transformers and auxiliary generator bus tie; 13 600-amp. for feeders, bus ties and primaries of 440-volt power transformers; 39 300-amp. for feeders, compensators and 440-volt transformer primaries, and 16 for auto transformer starting switches for motors.
MAKE—Westinghouse Electric & Mfg. Co.
TYPE—B2.
OPERATION—Remote controlled, solenoid operated at 125 volts d.c.
RUPTURING CAPACITY—16,000 amp. at 2500 volts.
MOUNTING—Concrete compartments.

440 VOLT AUXILIARY POWER OIL CIRCUIT BREAKERS

NUMBER INSTALLED—Fifteen 300-amp. for feeders, 440-volt transformers and transformer bus ties; four 500-amp. for feeders and three 1200-amp. for 440-volt transformers and transformer bus ties.
MAKE—Westinghouse Electric & Mfg. Co.
TYPE—300 and 500-amp. Type F2, and 1200-amp. Type B2.
OPERATION—Remote controlled, solenoid operated at 125 volts d.c.
RUPTURING CAPACITY—15,000 amp. at 440 volts.
MOUNTING—Pipe framework.



Turbines and condenser pit looking southeast from grade.

Main turbine and generator room showing straight line assembly.

Cohokia—an artist's impression.

Union Electric Light & Power Company's new Cohokia Station — first completed unit showing Mississippi River bridges to St. Louis, Mo.

Boiler room, at feeder level looking north, showing pulverized fuel equipment.

This station was put into service on October 15, 1923, or about 13 months after the first pile was driven, because of the urgent demand for additional power.

Since then one turbo-generator has been continuously in commercial service, the other intermittently from November 30 to February 20 and continuously since the latter date.

Seven boilers were put into steaming service on various dates from October 2 to January 10, the eighth boiler on February 15, and the various elements of coal handling and coal preparation as needed in advance of boilers and furnaces.

The total station economy from coal as received on car dump has been as follows:

	Btu. per Gross	Kw.-Hr. Net	Maximum Load Kw.	Capacity Factor	Net Output Kw.-Hr.
January (31 days)	17,922	19,310	40,000	30.3	13,503,200
February (29 days)	17,579	18,640	45,000	36.3	15,175,900
March (15 days)	17,339	18,360	45,000	47.0	10,145,400

The foregoing is exclusive of economizers or air preheaters, none having been installed, as the station was designed to burn low-grade coal averaging \$2.50 per ton. The station has not yet reached its permanent operating load, as indicated by the maximum load, the capacity factor and output given above.

No official or acceptance tests on principal equipment have so far been made except on the No. 1 turbo-generator.

MOTOR GENERATOR SETS

Numbers installed	2	2
Service	D.C. Power	Battery Charging
Make	Westinghouse	Westinghouse
Generator		
Capacity	100 kw.	25 kw.
Voltage	250 volts	125/175 volts
Rpm.	1160	1160
Winding	Compound	Shunt
Motor		
Size	150 hp.	35 hp.
Voltage	2300 volts	440 volts
Type	Squirrel Cage	Squirrel Cage
Auxiliary Exciter.		

TRANSFORMERS

SET-UP TIE FEEDER TRANSFORMERS—Three transformers, each 3-phase, delta-zigzag, 12,000-kva., 60 cycle, 13,800/33,000 volts, forced oil cooled, General Electric Co.

STEP-UP FEEDER TRANSFORMERS—Three transformers, each 3-phase, delta-zigzag, 7500-kva., 60 cycle, 13,800/33,000 volts, forced oil cooled, General Electric Co.

STATION POWER TRANSFORMERS

Two transformers, each 3-phase, delta-delta, 3000-kva., 60-cycle, 13,800/2300 volts, self and water cooled, General Electric Co.

Two 3-phase, delta-delta, 750-kva., 60-cycle, 2300/440 volt, self cooled oil insulated Westinghouse Electric & Mfg. Co.

Two 3-phase, delta-delta, 200-kva., 60-cycle, 2300/440 volts, self cooled oil insulated Westinghouse Electric & Mfg. Co.

STATION LIGHTING TRANSFORMERS—Two single-phase transformers, 150-kva., 60-cycle, 2300/220/110 volts, self cooled, oil insulated Westinghouse Electric & Mfg. Co.

DISCONNECTING SWITCHES

LOCATION—All disconnects for 13,800-volt oil circuit breakers are S. P. S. T. and are located in the same compartment as the oil circuit breaker.

OPERATION—Remote hand operated from floor below lowest phase.

MAKE—General Electric Co.

GENERAL—All 2300 and 440-volt disconnects are S. P. S. T.

OPERATION—Hook stick.

MAKE—Electric Power Equipment Corporation.

MAIN CURRENT TRANSFORMERS

MAKE—General Electric Co.

TYPE—Single turn primary, single coil secondary.

MAIN POTENTIAL TRANSFORMERS

MAKE—General Electric Co.

TYPE—Oil insulated, with one fuse and current limiting resistor for star connection.

REACTANCE COILS

MAKE—General Electric Co. for generators and bus ties; Metropolitan Device Corp. for feeders.

NUMBER INSTALLED—Six for generators; 3 for main bus tie and 24 for feeders.

TYPE—Single-phase, concrete clad.

REACTANCE—5 per cent for main and ring bus ties; 4 per cent for outgoing feeders; 3 per cent for generators and outgoing feeders, and 220-kva. saturated core reactors for 2300-volt inter-bus ties.

STORAGE BATTERIES

SERVICE—D.C. control and emergency lighting.

NUMBER INSTALLED—Two.

MAKE—The Electric Storage Battery Co.

CAPACITY—81 amp. for 8 hrs. and 360 amp. for 1 hr.

NUMBER OF CELLS—63.

TYPE—F-19 in wood tanks.

VOLTAGE—126 volts.

MAIN GENERATOR AND TIE FEEDER CONTROL BENCHBOARD

Comprising the following sections: Two 35,300-kva., 13,800-volt, 60-cycle generator sections; two sections each having two 12,000-kva., 13,800-volt, 60-cycle station tie feeders and one section for 13,800-volt bus tie and neutral ground, one bracket section for voltmeter and synchronizing indicators.

MATERIAL OF PANELS—2-inch, oil finished, natural black Monson slate.

MAKE—General Electric Co.

MAIN FEEDER CONTROL SWITCHBOARD

Comprising the following sections: Two sections having one 3000-kva., 13,800/2300-volt station transformers and one 5000-kva., 13,800-volt feeder; three sections having one 5000-kva., 13,800-volt feeder and one 7500-kva., 13,800/33,000-volt feeder and two sections having two 5000-kva., 13,800-volt feeders.

MATERIAL OF PANELS—2-inch oil finished, natural black Monson slate.

MAKE—General Electric Co.

AUXILIARY GENERATION GROUP CONTROL SWITCHBOARD

Comprising the following sections: Two 2500-kva., 2300-volt, 3-phase, 60-cycle generator sections; two 3000-kva., 13,800/2300-volt, 3-phase, 60-cycle transformer sections; two 750-kva. and 200-kva. 2300/440-volt, 3-phase, 60-cycle transformer sections, one voltage regulator section and one swinging bracket type synchronizing panel.

MATERIAL OF PANELS—2 in. oil finished, natural black Monson slate.

MAKE—All panels are Westinghouse except voltage regulator panel, which is General Electric Co.

MOTORS

104 induction motors up to 150 hp. Wagner Electric & Mfg. Co.

15 induction motors above 150 hp. General Electric Co.

14 d.c. motors. Westinghouse Electric & Mfg. Co.

D.C. POWER AND CONTROL BOARDS

D.C. POWER BOARD controls the following: Two 100-kw., 250-volt motor generator sets; one 300-kw., 250-volt reserve exciter, one 200-amp. feeder for magnetic pulleys on conveyors and two 800-amp. feeders for fuel feeder drive motors.

BATTERY CONTROL PANEL—125-volt d.c. controls the following: Two 63-cell, 125-volt storage batteries; two 25-kw., 125/175-volt motor generator sets; 8 200-amp. feeders 125-volt 2-wire for valve motors, station emergency light rheostat and governor motors, d.c. circuit breaker controls; fuel signal and annunciator systems; 16 400-amp. feeders 125-volt 2-wire, for motor generator and battery circuit breaker controls and oil switch tripping and closing circuits.

MAKE—Electric Power Equipment Co.

MATERIAL OF PANELS—2-in. oil finished, natural black Monson slate.

Lighting Panels

For control of the following: Twelve 200-amp. 220/110-volt, 3-wire a.c. feeders for lighting circuits in switch house, turbine room, boiler house and yard lighting, for normal lighting; and nine 60-amp., 110-volt, 2-wire feeders for emergency lighting in same locations with the exception of yard lighting.

GENERAL—All lighting including emergency lighting is fed normally from the a.c. supply. The lighting switchboard is provided with a 400-amp. automatic throw-over switch which connects the feeders to the battery supply if the a.c. supply fails.

MAKE—Electric Power Equipment Co.

MATERIAL OF PANELS—2-in. oil finished, natural black Monson slate.

Neutral Grounding Equipment

MAKE—General Electric Co.

OIL SWITCHES—Two 1200-amp. S. P. S. T., 15,000-volt, motor operated. (One none-automatic, one automatic.)

Type FHD-17 oil circuit breakers. (Automatic breaker shunts resistance after 2-minute interval.)

DISCONNECTING SWITCHES—Two 1200-amp., S. P. S. T. 15,000-volt, Type LG-116.

GROUNDING RESISTANCE—One 1300-amp., 6-ohm non-inductive grounding resistance, 2-minute rating.

MISCELLANEOUS

WIRE AND CABLE—General Electric Co., Standard Underground Cable Co., Simplex Wire & Cable Co., Safety Insulated Wire & Cable Co., American Steel & Wire Co., United States Rubber Co., Crannell, Nugent & Kranzer.

BUS COPPER AND GROUND PLATES—Rome Brass & Copper Co.

BUS AND CABLE SUPPORTS AND INSERTS—Electrical Development & Machine Co. Number Installed—2560.

HIGH TENSION BUSHINGS—R. Thomas & Sons. Number Installed—900.

CABLE CLAMP INSULATORS—General Device & Fitting Co. Number Installed—32.

TROLLEY WIRE—American Copper Products Corp.

TROLLEY WIRE SUPPORTS, TURNBUCKLES, ETC.—Electric Service & Supplies Co.

IRON CONDUIT—Western Electric Co., Manhattan Electrical Supply Co.

FIBRE CONDUIT AND BENDS—Johns-Manville Co.

GENERATOR TEMPERATURE RECORDERS—General Electric Co. Number Installed—2.

TELEGRAPH PEDESTALS AND INDICATORS—General Electric Co. Number Installed—4.

KILBERSCOPE SYSTEM—One Kilberscope system was installed, consisting of one indicator in the main control room and one in the boiler house for notifying the boiler watch engineer of anticipated load requirements. Each indicator is composed of one Kilberscope instrument made by the Weston Co. and calibrated to read "Kilbers" (thousands of pounds of steam per hour). 24 General Electric Co. indicating lamps and 24 Western Electric Co. jacks, each representing one-half hour intervals. Kilberscope instruments are controlled by a rheostat in main control room. One 8-inch vibrating type Signal Engineering Co. bell in the boiler room calls the attention of the boiler watch engineer to the instrument.

FIRE ALARM SYSTEM—Gamewell Fire Alarm Tel. Co.

SASH MOTOR CONTROLS—Cutler-Hammer Co. Number Installed—2.

KINNEAR ROLLING DOOR CONTROLS—Westinghouse magnetic switches. Number of controls installed—2.

LIGHTING CABINETS—Frank Adams Electric Co. Number installed—16.

SHEET STEEL JUNCTION BOXES—All Steel Equipment Co., Columbia Metal Box Co.

LIGHTING FIXTURES—Porcelain enameled steel reflectors and marine type fixtures, Benjamin Electric Mfg. Co.; glass reflector fixtures, The Holophane Co.; water column illuminators, The National Co.; miscellaneous fixtures and fittings, Crouse-Hinds.

STRUCTURES

POWER PLANT BUILDINGS containing boiler room, turbine room, electrical and river bays.

DIMENSIONS

Length—173 ft. (present), 650 ft. (ultimate).

Width—221 ft.

Height—104 ft. above new ground level.

TYPE OF CONSTRUCTION—Brick curtain walls on steel frame. Foundations—Concrete mat. on concrete piles. Reinforced concrete floors.

SUBDIVISIONS (between column centers)—

	Width	Present Length	Ultimate Length
Boiler room	106 ft.	171 ft.	630 ft.
Turbine room	58 ft.	193 ft.	672 ft.
Electrical bay	36 ft.	171 ft.	630 ft.
River bay	21 ft.	171 ft.	630 ft.

FOUNDATIONS

1121 Precast concrete bearing piles.

170 Precast concrete sheet piles.

1422 Cast in place concrete piles.

PIILING by Raymond Concrete Pile Co.

WATERPROOFING of substructure up to grade 37 ft., 88,900 sq. ft. of fabric and asphalt membrane waterproofing. Waterproofing material by Gardner & Lewis, Inc.

Cutting Corners in Material Handling

Horizontal Conveyors, Vertical Hoists, Tractors, Cranes
Show Enormous Savings

By A. G. J. RAPP*

HISTORY tells us that the metallurgy of iron is an age-old art. Homer speaks of iron, used by the Greeks, twelve centuries before the coming of the Christ. At Delhi, India, stands an iron pillar which was first recorded eighteen centuries ago. In the fourth chapter of Genesis, Tubal Cain introduces us to "an instructor of every artificer in brass and iron." The possession of iron deposits and the ability to work such deposits has ever determined the commercial and political status of nations.

But though history sheds light upon the product as it came to us throughout the ages, it does not tell of the methods then employed in producing this all important commodity nor yet speak of the one costly element in its manufacture—the handling of materials. Though the gigantic pyramids of the Nile Valley yield implements of iron, how those implements were made or even how the pyramids themselves were raised is yet an unsolved mystery.

How to handle materials efficiently and with the least expenditure of energy was, no doubt, a problem of paramount importance with the peoples of dead centuries. Certain it is, material handling is still a major problem in every branch of manufacturing. As the possession and the ability to use iron has always determined the progress of nations, so the ability to move materials with the minimum of effort is today a determining factor in the progress of companies.

*Engineer, Link-Belt Company, Chicago.

The more corners a manufacturer can cut in his materials handling expense, the more profit he can show on the ledgers and the more expansion of enterprise is warranted. "Cutting corners" in materials handling, furthermore, is an assignment seldom delegated to one man alone. It is a game in which every department can participate, every foreman and every engineer take a hand.

One of the most interesting and perhaps the quickest way to further one's own game of cutting corners is to learn the experience of others—to find "how the other fellow does it." And to the end of illustration we introduce the Commonwealth Steel Company at Granite City, Ill., producers of steel castings for locomotive and railway car construction. The foundry of the Commonwealth Steel Company is one of the large steel foundries in the country. It has four open hearth furnaces at present, with a fifth under construction. Nine heats are run per day and approximately 200 tons of steel poured.

About 10 years ago a Peck carrier was installed for handling core sand to the core makers' benches. This equipment was selected because of certain construction features, such as the overlapping buckets and the fact that the buckets remain in a horizontal position at all times except when tripped for dumping. This unit for handling core sand is approximately 350 feet long. A second Peck carrier was installed in 1918 for facing sand which was about 550 feet long. (This is one of the longest Peck carriers



Plymouth gasoline locomotive in constant operation at the plant of the Tennessee Copper and Chemical Company, Lockland, O.

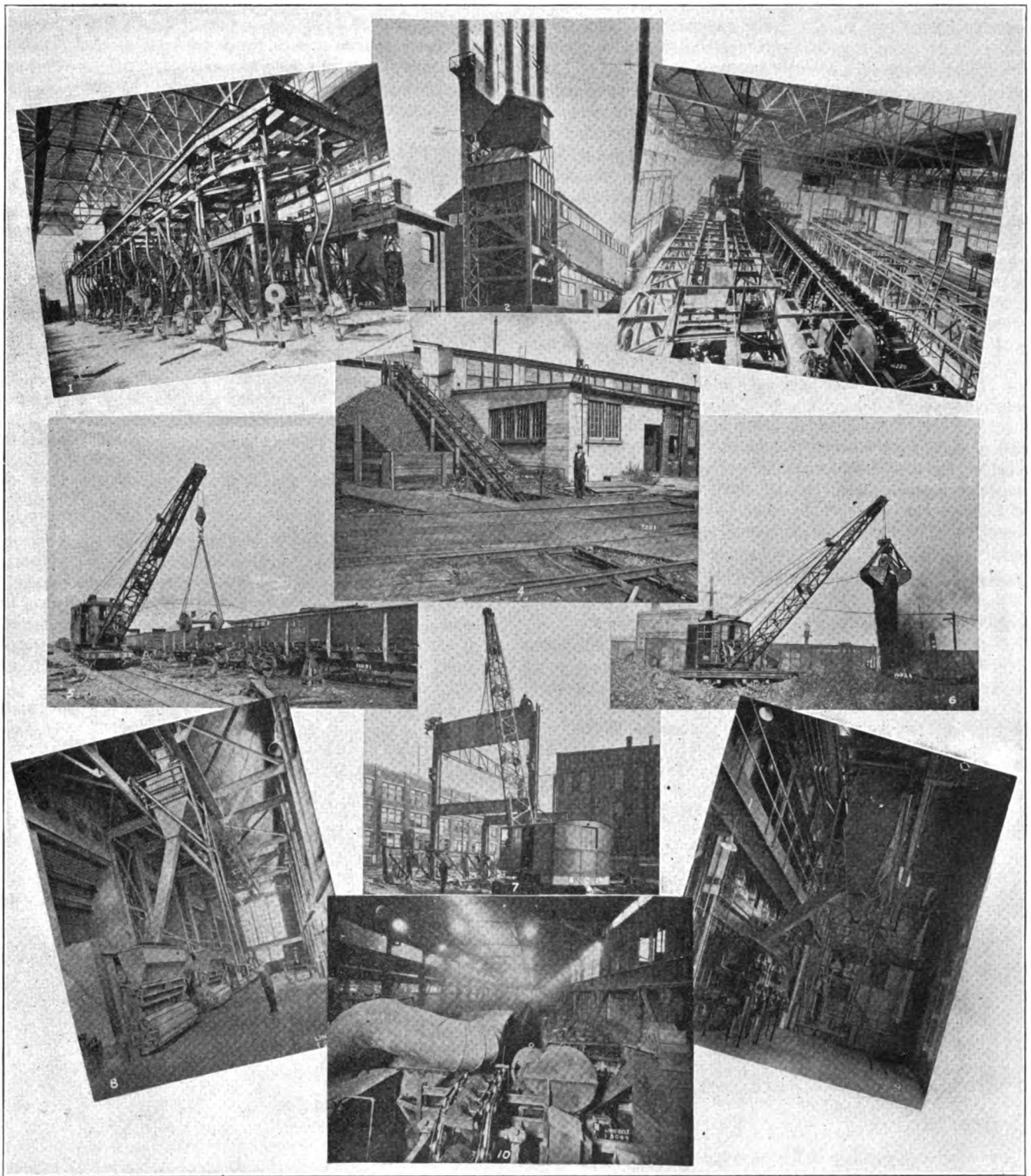


FIG. 1—Detail view of the endless mold conveyor shown in Fig. 3. FIG. 2—Illustrates the skip hoist in operation at one of the Crucible Steel Company's plants near Pittsburgh, Pa. The skip hoist method of handling ashes, mill refuse, coal, and so forth, has become a standard practice with steel plants. Under many conditions it affords the most economical method for temporary storage or disposal of bulk materials. FIG. 3—Showing the complete foundry equipment of Kelsey Wheel Co. This installation, according to W. J. Kalty, saves 90 per cent of the floor space and 50 per cent of the men necessary as labor. In other words it does twice as much work as was formerly accomplished in 1/10 the floor space. FIG. 4—Illustrating the flight conveyor used to store coal at the foundry of the American Car and Foundry Co., Wilmington, Del. 5-in. x 15-in. flights—every 2 ft.—100 f.p.m. Capacity 25 tons per hour. FIG. 5—Link Belt Locomotive Crane aiding production at General American Tank Car Corp., East Chicago, Ind. FIG. 6—Locomotive crane saving the labor of 30 men in coal handling at a large coke and gas producing company. FIG. 7—Illustrating one of the many uses to which a gasoline, crawler type crane can be put. FIG. 8—View of boiler house showing man operating weigh larry at Cornell University. January, 1924. FIG. 9—This is a close up view of the five-ton weigh larry. Penn Central Power Co., Philadelphia, Pa. January, 1924. FIG. 10—550 ft. Peck Carrier handling facing sand at Commonwealth Steel Company, Granite City, Illinois.. This conveyor saves the labor of 100 men over the old system it replaced.

ever installed.) Last year a third carrier was put in for core sand and in the new extension being made to the foundry a fourth carrier will be put in operation. The latter will handle facing sand.

The arrangement of the carrier used for molding sand permits the carrying of both used sand and facing sand by the conveyor. The return line of the carrier runs in a tunnel under the molding floor. Gratings are placed over the conveyor, and when the flasks are shaken out upon the gratings, the sand falls into the buckets. This sand is carried almost to the end of the foundry, where it is dumped on an inclined belt conveyor leading to the sand mills. On the way to the sand mills, however, new white sand and fire clay are added automatically.

After the sand has been thoroughly mixed by the sand mill it discharges into the buckets of the Peck carrier and is elevated and conveyed to the hoppers over the molding stations. A man sets the tripper which causes the buckets to dump into the hoppers and he sees to it that all the hoppers are supplied with sand. The molder, when he wants sand, simply swings the chute from the overhead hopper to the proper position, pulls the discharge control, and the sand flows in a stream to wherever he wants it. No shoveling is required as the sand is led right into the flask.

Present Method Saves 100 Men.

Before this equipment was installed, dump cars hauled on a narrow gauge railway by an electric locomotive were used for bringing the sand from the sand mills to the molders. It was merely dumped in piles and the molder shoveled it into the flask. This method was in no way as efficient as the present one. In fact, the present system of overhead hoppers, Peck carrier and the sand conditioning machinery saves the labor of fully 100 men. At \$4.20 a day this amounts to \$126,000 annually—and this gross saving is obtained from an installation which cost, at the time it was installed, about \$175,000.

Considering the hard usage these conveyors receive (the facing sand conveyor was said by the engineer who installed it to be the most abused Peck car-

rier in the country) repair costs have been remarkably low. It is necessary to rebush the wheels once in about three years, and replace a chain pin occasionally. But whatever repairs are necessary must be made on Sunday, as the conveyors cannot be laid up. Once a week the wheels are oiled. This is done while the carrier is running, by injecting oil under pressure into the oilers as the wheels are in the vertical part of their travel and not revolving.

Very little power is needed to drive this equipment. The facing sand carrier has a 25-hp. motor, but it only develops 10-12 hp. The core sand conveyors use about 4 hp each. The facing sand conveyor has two operators, one who distributes the sand among the hoppers, the other looking after the lower run. One man for each core sand conveyor keeps the core-makers' hoppers filled. The conveyors do not run steadily throughout the 24 hours of the day, but total about 16 hours' operation each day. The capacity of the facing sand equipment is 60 tons per hour, and the core sand conveyors 25 tons the hour. The life of the bucket conveyors seems to be indefinite, because the first one, after 10 years' use, is still in splendid condition.

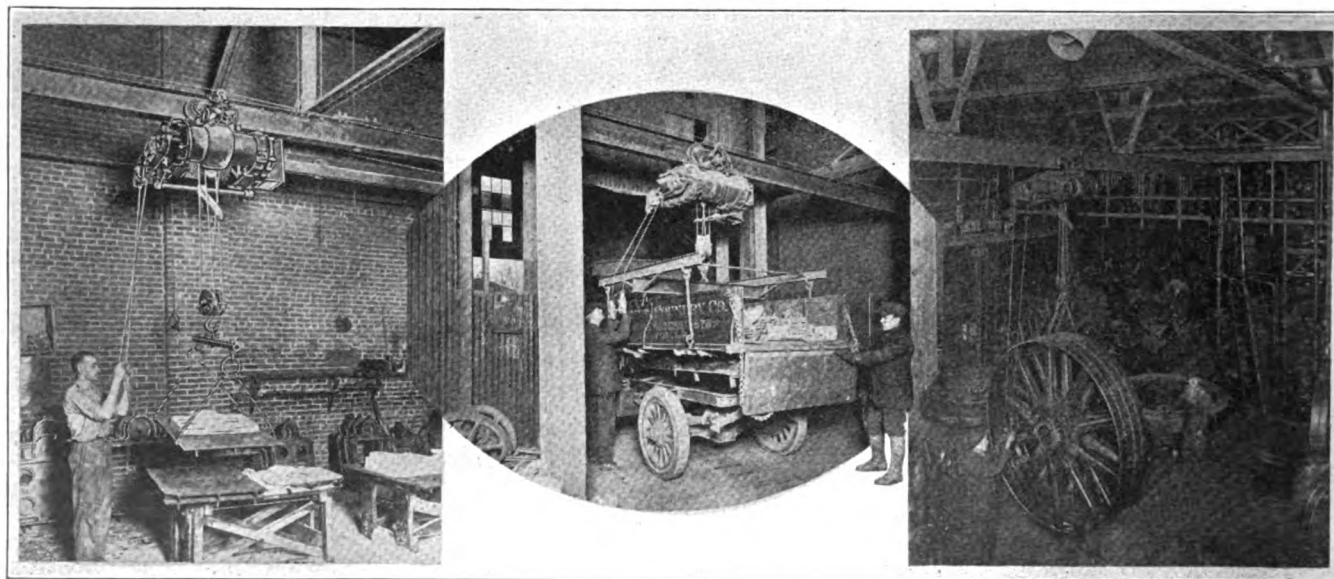
Increasing Production and Eliminating Rehandling with Locomotive Crane.

Another modern implement for material handling which is used extensively in steel plants is the locomotive crane. So universal have they become and so necessary a portion of the steel plant's equipment that it is difficult to visualize conditions or the number of men it would be necessary to employ if such cranes were suddenly made unavailable.

A concrete instance of what locomotive cranes are doing for such plants is to be had at the General American Tank Car Corporation, East Chicago, Ind. Mr. William Bald, master mechanic, says:

"Our locomotive cranes more than pay for themselves by the extra odd jobs they do around our plant, such as switching freight cars, moving heavy objects and handling building materials.

"We use four such cranes, equipped with hook and chain for unloading cars of steel plates and shifting



Left—Showing how the electric hoist is capable of performing the most delicate work as well as the rough, heavy tasks. Here shown handling fragile core sand in a foundry. Middle—An unusual use to which an electric hoist has been put. With the trolley and I-beam extending over a driveway, this hoist lifts the body with contents off of a truck, replacing it with an empty box. This saves delivery truck time sufficient to far more than pay the cost of the hoist. The convenience to the men in loading or unloading truck bodies is also an appreciated result of this method. Right—Illustrating the rough usage and heavy duty capable of the electric hoist.

tank parts and tanks weighing from 1 to 10 tons, from one section of the plant to another—work which cannot be handled by manual labor because of the excessive weight and bulk.

"At the time we erected our new 125x300 ft. building, the cranes were particularly valuable. Equipped with 75-ft. extension booms, they hoist and hold steel members steady until they are bolted in place. Later the heavy equipment for this building was lifted and set by the locomotive cranes.

"With our cranes, two of the 25-ton capacity, one of the 20-ton and one of 15 tons, we save thousands of dollars annually, because they speed up production, eliminate rehandling of material and do the work that cannot be done with our other equipment or with hand labor."

A rather unusual crane application was recently made by the Carpenter Steel Company of Reading, Pa. The specifications called for a gasoline, crawler type crane so equipped that it could not only handle a grab bucket or hook block, but also a standard 45-in. magnet for pig iron.

This sort of equipment involved providing this gasoline operated crane with its own generator and lifting magnet equipment in addition to the regular lifting and propelling mechanism. This requirement might have presented difficulties with the ordinary type of crawler crane but, it is said, the Link-Belt crawler crane possesses such an abundance of cab and operating room that the establishment of an extra generator incurs no difficulties.

A lifting magnet of the sort furnished handles upwards of 1,500 pounds of pig iron or about 1,200 pounds of scrap and is the usual type seen in use on locomotive cranes about the average industrial plant.

Another instance of labor economy through the use of locomotive cranes comes from S. H. Hunt, chief engineer for a large coke and gas producing company. Mr. Hunt states:

"In handling large quantities of coal quickly and efficiently from cars to coal pile and vice versa, the locomotive crane has a very decided advantage over hand labor.

"And although we installed this crane originally to load and unload coal, we have found that it performs equally well many other jobs about the yards. For example, we use it for switching cars, unloading mud scows, driving piles, dredging the river at our dock and cleaning up the yard. This is work which, if done by hand, would require many men and heavy expense.

"Fully 30 men would be required to load and unload from 12 to 15 cars in eight hours. This work we now do easily with one locomotive crane and four men. Indeed, we found that our crane more than paid for itself in the time and wages saved, during the first year."

Where coal requirements are in excess of eight or 10 cars a day, and particularly where the storage is made direct to overhead bins, the gondola car dumper is perhaps the most efficient and speedy of all mechanical means. The dumper is completely controlled by one man—the movement of a single lever (comparable to the control lever of a street car) governing all operations.

Any gondola car of standard size is accommodated by this car dumper and is rotated, dumping the contents into a hopper in one minute, ten seconds. Two

minutes is ample time for the complete operation of spotting the car, rotating and dumping, then shoving the empty off the dumper to make room for the succeeding load. The entire rotating operation is performed by a 35-hp. motor (which ammeter readings have shown to develop no more than 20 hp.) and the top clamp motor is of 10 hp.

During the construction of this dumper and before it was available for operation, coal was obtained from bottom dump cars and spotted over the hopper. The difference between the time and labor necessary to handle coal in this fashion and the speed with which the dumper now dumps coal, convinced McClellan & Junkersfeld, construction engineers for the Cahokia Plant, that the gondola car dumper will justify its cost and earn its keep on eight or ten cars of coal a day.

Coal Handling Machinery for Inland Steel Coke Plant.

The Inland Steel Company, Indiana Harbor, Ind., employs a very interesting coal handling system for their coke plant—an installation that is interesting if only from the fact that it has been in continuous operation for 10 or 12 years.

Coal is received in cars operating on double tracks which parallel the coal storage on the east or coke plant side, and are the connecting link between the coal handling and the coal crushing plants. From the cars the coal drops through track hoppers to a 42-in. apron conveyor which carries the coal across 50 feet to a 36-in. belt conveyor having a capacity of 400 tons per hour and on which the coal is elevated into the two hoppers of the crusher building. Each hopper has a capacity of 140 tons. By means of a reciprocating feeder the coal is fed from each hopper into a 12x14-ft. Bradford breaker, the coal being handled at the rate of 200 tons per hour. The refuse from the breaker is discharged upon a 24-in. belt conveyor and elevated to a refuse tower from which the refuse is loaded into cars. The coal from the breaker drops onto a 36-in. inclined belt conveyor which carries it to the hammer mills. Through two-way spouts the crushed coal from the mills is discharged onto two 36-in. belt conveyors and is carried up into the 400-ton bins of the mixer building. The arrangement of the equipment and conveyors in parallel for handling the coal through the crusher building and to the mixers, provides for the two grades of coal used. From the foot valves of the two mixers the crushed coal is brought together on two 36-in. belts, each with a capacity of 100 tons per hour, delivering to the coal mixer. The coal mixer delivers to a 36-in. belt conveyor that carries the coal up to the 1,300-ton storage bins from which the over laries are loaded. From the storage yard to the coke laries the coal moves in process of crushing and mixing an approximate distance of 875 feet.

System of Conveyors Saves 90 per Cent in Floor Space and Doubles Production.

Another interesting instance of the economy in both time and labor which can be effected by mechanical means is found at the Kelsey Wheel Company of Detroit. With regard to this equipment, W. J. Klatz, general superintendent, says: "The results we have obtained from using Link-Belt mold conveyors, applied to make possible the progressive assembly plan, have been quite remarkable. In the first place this system has enabled us to double our production be-

cause we begin pouring the metal into the molds on the conveyor at 8:30 in the morning, while before using the system, and when laying the molds on the floor, the entire morning was spent preparing for the pouring, leaving but half the day for actual pouring—and as the average per hour is the same by both methods the conveyors save half a day.

"Second, by handling this work by conveyors, only one-tenth of the floor space otherwise needed is used.

The foregoing are but a very few of the unnumbered instances where mechanical means have proven a source of economy and efficiency over hand labor.

And while the steel industry, of all industries, perhaps needs least the admonition to employ mechanical means, yet it is well to recognize that there is every indication that immigration restriction will be increased and that the existing shortage of labor will not only continue, but actually grow.

Hence it is even more true of the future than of the past that: "As the possession and the ability to use iron has always determined the progress of nations, so the ability to move materials with the minimum of effort is today a determining factor in the progress of industrial enterprises."

Fireless Locomotive Saves Fuel

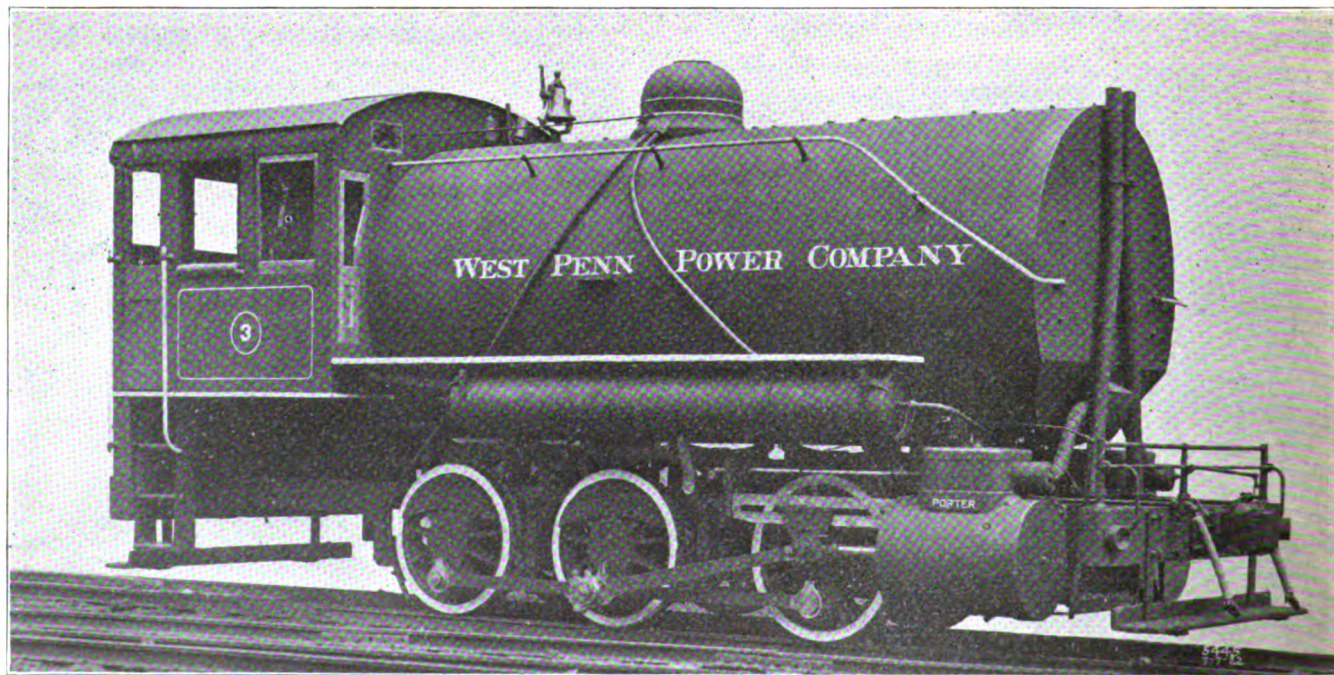
By C. E. COLBURN*

AT the Springdale Power Station of the West Penn Power Company, a fireless steam locomotive has been in successful operation for the past year and a half. The steam used by this locomotive is taken from a heat accumulator which takes the place of the boiler on the ordinary locomotive. The accumulator is 6.79 feet in diameter and 21 feet long, of cylindrical construction with convex heads and holds 45,500 lbs. of water at 212 deg. F. This accumulator is charged with steam at 300 lb. pressure until the temperature of the water is raised to nearly 425 deg. F. When charged to this temperature a total of 17,730,000 B.t.u. above 32 deg. F. is stored in the water. 1.35 per cent of this stored heat will be given up to the generation of steam if the temperature of the water is allowed to drop to 365 deg. F., which is about the point at which it becomes necessary to recharge because of the pressure falling so low that the power and efficiency of the engine is reduced. Assuming an average

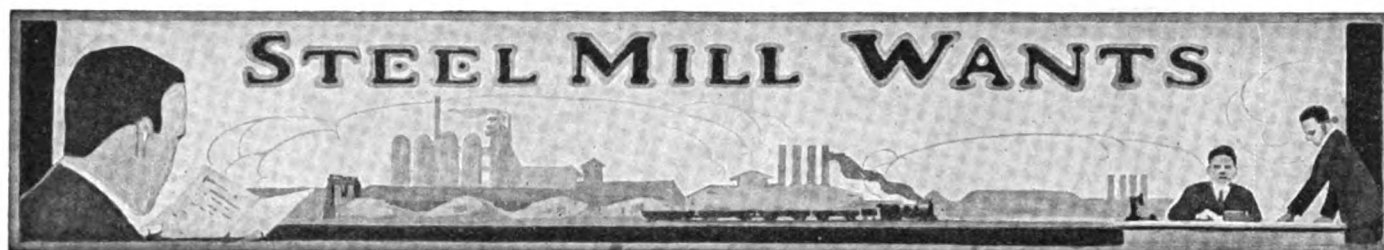
engine thermal efficiency of 10 per cent, the work that can be done by the stored heat is 95 hp. The loss of heat by radiation from the accumulator is small, it being possible to go 8 hours without recharging on the coldest winter days.

As the pressure of the steam supplied to the cylinders by the accumulator falls it is necessary to increase the length of steam admission. After the steam pressure has been considerably reduced it is necessary to admit steam during nearly the whole of the stroke when pulling heavy loads. With this admission there is not complete expansion and a lowered efficiency results. For this reason the accumulator is charged frequently so as to keep it on the average as nearly fully charged as possible and obtain the highest efficiency. Although the average efficiency of the engine is somewhat low due to the incomplete expansion at times, this is more than compensated for by the fact that heat furnished the engine is generated at high efficiency in the large boilers of the station.

*West Penn Power Company, Springdale, Pa.



A power company combines the factors of low-steam-costs, flexibility, safety, reliability in the operation of the fireless locomotive shown above. This Porter machine weighs in working order, 135,000 lbs., has cylinder diameters of 24-in. by 24-in. stroke, drivers 46-in. diameter, with total tractive force of 25,000 lb.



POSITIONS WANTED

STEEL FOUNDRY manager or general superintendent, expert in open hearth, converter and electric steel, alloyed rolls, large and small castings; practical molder, 22 years of experience. Expert in production, efficiency. Metallurgical and Mechanical Engineer. University graduate, with broad technical and commercial experience. Married, age 42. My castings made by my process are guaranteed to be free from blow holes or segregation and are equal to forgings. Nailing molds or cores is eliminated. My cores made by my process will clean out of steel castings as free as they will out of iron castings. Will reduce the consumption of new sand. Will guarantee to put your steel foundry on a maximum paying basis. A demonstration will cost you nothing. Address Box A I Q, The Blast Furnace and Steel Plant.

OPEN HEARTH assistant superintendent desires to make a change. Would like position with company needing young man with wide experience. Am 29 years old and married. References. Box F W G, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Steel foundry superintendent now ready to confer with parties wanting a real, live executive who knows how to produce castings and get results in cost and production and who can systemize shop without excess red tape; have had 20 years' experience and can furnish A1 reference; have no objections to going to foreign plant. Box A D C, care of The Blast Furnace and Steel Plant.

WORKS ACCOUNTANT or chief clerk, having 15 years production costs, orders, shipping, time, payroll, stores and general accounting experience in blast furnaces, steel plants and mills, desires clerical-executive position offering future and permanent connections. Box B B, care of The Blast Furnace and Steel Plant.

CHIEF ENGINEER or assistant to general manager. Experienced executive with technical training; 15 years' experience, covering design and construction of mills, furnaces and general steel plant equipment; age 37. Box C L A, care of The Blast Furnace and Steel Plant.

POSITION WANTED by metallurgist, thoroughly versed in metallography and heat treatment of iron and steel; at present employed by one of the largest steel plants in middle west; graduate of a leading technical university; three years' practical experience. Box A E E, care of Chicago Office, The Blast Furnace and Steel Plant.

POSITION WANTED—Blast furnace manager or general superintendent with splendid present as well as past record; at present employed, desires change. Chemical and metallurgical training together with 18 years' experience in the manufacture of basic, foundry malleable and Bessemer irons; familiar with both Northern and Southern practice. Expert in designing, operating and organizing; highest of references. Do you require the services of a high class man who will guarantee increased production as well as lowering production costs? My reputation and records will interest you. Address S H R, care of The Blast Furnace and Steel Plant.

INSPECTOR AND EXPEDITOR—With eight years' experience in expediting and inspecting of materials and machinery for by-product coke plants, power houses, blast furnaces, rolling mills, wheel mills, etc. At present am connected with one of the large steel companies in the Pittsburgh District on construction. As this work is about completed will be open for another position very soon. I prefer a position which will keep me on the road a major portion of time. Box F S H T, care of The Blast Furnace and Steel Plant.

STEEL ANALYST, 30, five years' experience, college graduate, desires supervision of laboratory. Box O L I, care of The Blast Furnace and Steel Plant.

SITUATIONS WANTED

MASTER MECHANIC with wide experience in blast furnaces and steel works wishes to make change. A-1 references. P.O. Box 333, So. Brownsville, Pa.

GRADUATE mechanical engineer with fifteen years' experience is engineer, designer, estimator, inspector, production manager, and sales-engineer in hoisting and curveying equipment, is seeking a new connection in the Pittsburgh district as engineer, sales-manager, purchasing agent, or district representative. Could become financially interested. Box 466 care of Blast Furnace and Steel Plant.

STEEL Mill Superintendent — Young married man with several years' experience as superintendent of steel mills, blooming, billet, rail, sheet bar, skelp and rod mills, making and rolling various kinds of common and alloy steels, also brass, bronze and copper, would like to make a change and become associated with a company that offers quicker opportunities than I have at present. Can furnish references of the highest grade, both previous and present employers. Box 754 care of the Blast Furnace and Steel Plant.

WANTED

BABBITT metal and solder salesman with old established Middle West firm. State qualifications and territory. Replies held strictly confidential. Box J M J, care of The Blast Furnace and Steel Plant.

WANTED—Cold strip mill superintendent; competent man, familiar with Middle West trade and its requirements, for steel plant producing hot and cold roll strip. Box 101, care of The Blast Furnace and Steel Plant.

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WANTED — Metallurgist with experience in manufacture of special analysis sheets for plant investigation. Box 1 care of Blast Furnace and Steel Plant.

WANTED — Position as superintendent or assistant superintendent of open hearth by man aged 30. Technical education and five and one-half years' practical experience on furnaces and as superintendent of department. Box 630 Care of Blast Furnace and Steel Plant.

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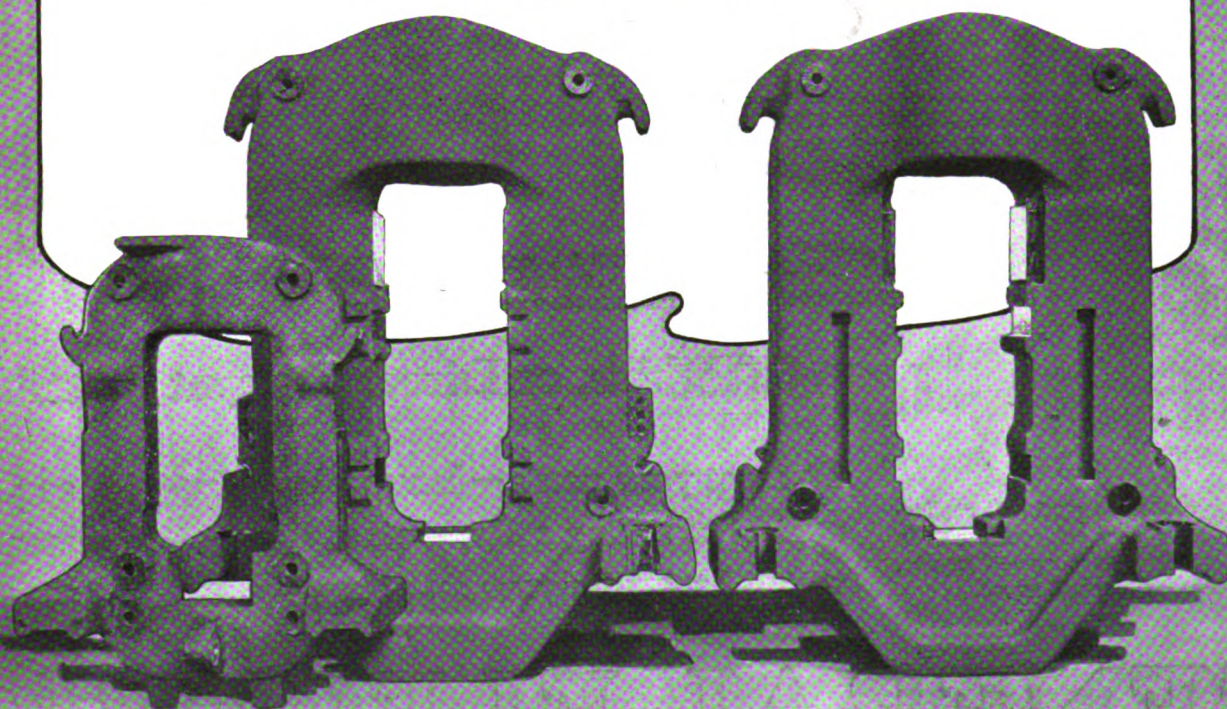
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